VOLUME 2 January-December, 1953 Nos. 1 & 2

THE PHILIPPINE JOURNAL of FISHERIES

Published Semiannually by the
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES

Republished by
BUREAU OF FISHERIES AND AQUATIC RESOURCES
Quezon City, Metro-Manila
Philippines
1977

CONTENTS

No. 1, January–June, 1953

[Issued August 26, 1954.]

Page

MANACOP, PORFIRIO R. The life history and habits of the goby, Sicyopterus extraneus Herre (anga) Gobiidæ with an account of the goby-fry fishery of Cagayan River, Oriental Misamis 1
Three plates and ten text figures.

MEGIA, T. G., and D. V. VILLADOLID. A contribution to the knowledge of the structure and composition of the water masses off eastern Philippines 61
Five plates and eleven text figures.

RONQUILLO, INOCENCIO A. Food habits of tunas and dolphins based upon the examination of their stomach contents 72
Two text figures.

UYENCO, V., P. RODRIGUEZ, and R. TARUC. Studies on the salt concentration of commercially dried (tuyo) and smoked (tinapa) herring 84
One text figure.

SALAMANCA, ENRIQUE S. The effect of salt, vinegar and heat on the coliforms in oysters 90
Four text figures.

SULIT, JOSE I., OLYMPIA B. NAVARRO, REGINA C. SAN JUAN, and ELISA B. CALDITO. Proximate chemical composition of various species of Philippine market fishes 106
One text figure.

No. 2, July–December, 1953

[Issued March 21, 1955]

MANACOP, PORFIRIO R., and SANTIAGO R. CAPCO. The goby dredge-trawl fishery of Laguna de Bay, with notes on the composition of the commercial catches 121
Five plates and eleven text figures.

VILLADOLID, D. V., TEODORO G. MEGIA, and INOCENCIO A. RONQUILLO. An outlook of the Philippine tuna fisheries 158

MEGIA, TEODORO G., and ALFONSO R. SEBASTIAN. Equipment and methods used in oceanographic investigations in the Philippines 161

SULIT, JOSE I., BIENVENIDO DATINGALING and PACIFICO PAÑGANIBAN. Development of a coal-tar net preservative 168
Five text figures.

ABLAN, GUILLERMO L. Two Philippine boring molluscs 184
One plate.

ABLAN, GUILLERMO L. Lattice method of oyster culture 189
Three plates.

MEGIA, TEODORO G., INOCENCIO A. RONQUILLO and RICARDO R. MEDINA. Notes and observations on the Danish deep-sea expedition of the "Galathea" to the Mindanao Deep 197

RASALAN, SANTOS A. The new hasang moderno, a fish corral used in the Philippine waters 205
Twelve text figures.

INDEX 229

VOL. 2 JANUARY-DECEMBER, 1953 NOS. 1 & 2

THE PHILIPPINE JOURNAL of FISHERIES

Published Semiannually by the
DEPARTMENT OF AGRICULTURE AND NATURAL RESOURCES

Republished by
BUREAU OF FISHERIES AND AQUATIC RESOURCES
DEPARTMENT OF NATURAL RESOURCES
Quezon City, Metro-Manila
Philippines
1977

ANNOUNCEMENT
1977-03-26

The reprinting of the Philippine Journal of Fisheries, Volumes 1-6, is being undertaken by the Bureau of Fisheries and Aquatic Resources (BFAR).

The BFAR started as a Section under the Bureau of Science created in 1907. Under Act No. 4003 known as "Fisheries Act" passed in 1932, it was expanded into a Fisheries Division under the Department of Agriculture and Commerce. The Bureau of Fisheries was created under the Department of Agriculture and Commerce pursuant to Republic Act No. 177 which was approved on June 20, 1947 On March 20, 1963, the Bureau was absorbed by the Philippine Fisheries Commission which was created by virtue of Republic Act No. 3512 placing it under the direct control and supervision of the Secretary of Agriculture and Natural Resources.

With the reorganization of the executive branch of the national government under Presidential Decree No. 1 dated September 22, 1972, the Philippine Fisheries Commission was reverted to the Bureau of Fisheries in accordance with the Integrated Reorganization Plan. Presidential Decree No. 461 authorized the splitting of the Department of Agriculture and Natural Resources into the Department of Agriculture and the Department of Natural Resources. The same decree also renamed the Bureau of Fisheries and Aquatic Resources and is now under the control and supervision of the Department of Natural Resources.

Limited number of subscriptions for the reprints (Vol. 1-6) will be accepted by the Bureau of Fisheries and Aquatic Resources. Subscription rates for each volume of the Journal is US $10 for foreign and ₱20 in the Philippines.

Address all subscriptions to the Director of Fisheries, Attention: The Chief, Public Information Section, Bureau of Fisheries and Aquatic Resources, Arcadia Bldg., 860 Quezon Avenue, Quezon City, Philippines.

FELIX R. GONZALES
Director

THE PHILIPPINE
JOURNAL OF FISHERIES

VOL. 2 JANUARY–JUNE, 1953 NO. 1

THE LIFE HISTORY AND HABITS OF THE GOBY, SICYOPTERUS EXTRANEUS HERRE (ANGA) GOBIIDAE WITH AN ACCOUNT OF THE GOBY-FRY FISHERY OF CAGAYAN RIVER, ORIENTAL MISAMIS.[1]

By PORFIRIO R. MANACOP
Acquatic Biologist, Bureau of Fisheries

THREE PLATES AND TEN TEXT FIGURES

INTRODUCTION

ECONOMIC IMPORTANCE AND SCOPE OF THE FISHERY

The term goby fry, which is locally known as *hipon* (Visayan), or *ipon* (Ilocano), is generally applied to the young of a certain group of gobies and electrids that periodically appear in large swarms at the mouths of swiftly flowing streams in various parts of the Philippines. In the rivers of northern Mindanao, particularly in Cagayan River, the annual runs of this group of fish are so enormous in quantity that their catching and utilization constitute an important industry. There is a similar and equally important fishery in the north and northwestern parts of Luzon and in the southwestern part of Mindanao. But for lack of a systematic record of catch, the value of the fishery in Cagayan River can be estimated only roughly. The consensus of these estimates, as furnished by the fish traders, fishermen, and the local government officials, places the value of the goby fry fishery of Cagayan River at no less than

[1] A thesis submitted to the School of Biological Sciences and the Committee on Graduate Study of the Leland Stanford Junior University in partial fulfillment of the requirements for the degree of Master of Arts. June, 1941.

20,000 pesos annually. This same kind of fishery in northern Luzon, however, produces annually about 500,000 pesos worth of salted fish (Herre, 1927); that of northern Mindanao as a whole including that of Cagayan River, under the prevailing low level of exploitation, produces at least 100,000 pesos worth of catch annually. Were this fishery in northern Mindanao to be extensively and intensively exploited as is being done in northern Luzon, its production would possibly approach the yearly production of the latter place.

A relatively low production of the hipon fishery in northern Mindanao is to be expected from the way the fishery is exploited, for the fish are only taken for the commercial preparation of the salted fish paste (*bagoong*). This is done while the goby fry are still in the sea. When they begin to enter and ascend the fresh-water streams, a limited amount is taken for consumption in the fresh state. Such a practice, although not conducive to the extensive development of the fishery, is apparently a sound conservation policy, for it allows a large number of fry to escape upstream to replace the breeding stock.

Cagayan is a typical goby-fry producing river in the Philippines, characterized by being "boulder-strewn" and moderately flowing. It rises from the mountainous interior of Bukidnon Province at an elevation of from 5,000 to 6,000 feet above sea level. From these upland plateaus, it passes through deep gorges and over low falls through the coastal range which is about 30 kilometers from the sea. The coastal reaches of the river are chiefly characterized by pebbly beds with moderately swift-flowing currents, the depth of water varying from half a foot to 10 feet. In its upper reaches, the deep gorges have approximately 10 to 15 feet of water. All these conditions obtaining in this river are apparently ideal for the growth and multiplication of the species forming the chief sources of the goby fry fishery. The lower portion of the river passes close to the town of Cagayan, and finally empties into the head end of Macajalar Bay. The shallow approaches of Cagayan River including the tidal flats of Lapasan Cove cover the principal fishing areas of the goby fry. The river is fairly navigable during high tide, and launches having 7 feet draft can enter the river and proceed to the town of Cagayan, a distance of about 2 kilometers from the mouth. Above this point, or, specifically, above the Cagayan steel bridge, the river becomes shallow and rocky.

REVIEW OF LITERATURE

Although a number of investigations of the goby-fry fishery of the Philippines has been conducted by previous workers, no previous attempt has been made to study the unique life history and habits of any of the species forming this important fishery. Taylor (1919) made the first study of the kind in the ipon fishery of Abra River, northwestern Luzon. His report was chiefly a survey of the extent and commercial importance of the fishery, with some notes on the fishing methods used, and the seasonal appearance of the goby fry.

Herre (1927) made the first exhaustive taxonomic study of the Order Gobiodea of the Philippines and the China Sea in which the species forming this important fishery were definitely described. He made mention of the fact that the chief sources of the ipon fisheries in northern Luzon are the following species: *Chonophorus melanocephalus, Eleotris melanosoma, Glossogobius giurus, G. celebius, Ophiocara aporos,* and *Sicyopterus lacrymosus.* This statement was corroborated in later separate reports of the same fishery by Montilla (1931) and Blanco (1938). According to Dr. Herre's monograph and as far as is known to date, *Sicyopterus* is represented by at least five species in the Philippines. Three of them, namely, *Sicyopterus lacrymosus, S. fuliag* and *S. extraneus* are considered the most important sources of the hipon fisheries in the different parts of the Philippines (Herre, 1927). The first-named species is evidently the principal source of the ipon fishery along the Ilocano coasts of northern Luzon; the second species of Cagayan River, Cagayan Province; and the last of Cagayan River, Oriental Misamis Province, and possibly other rivers of northern Mindanao.

Sicyopterus extraneus, locally known as *anga* (Visayan) which was first described by Herre (1927) in Cabalian, Leyte Province, was later discovered by the writer to be the most important commercial species inhabiting Cagayan River, Oriental Misamis Province. This statement is corroborated in the present investigation. As a matter of fact, the major catch of both the young and adult in Cagayan River consists chiefly of this species.

Most of the published reports on *Sicyopterus extraneus* and related species both in the Philippines and in foreign countries, deal with the nomenclature, distribution, and some general notes on the breeding and feeding habits of the group. Ac-

cording to Herre (1927), the distribution of the various species of *Sicyopterus* ranges from Japan to Samoa and to the Society Islands, and from Hawaii to Burma and Isles of Reunion, the center of distribution being in the East Indies.

Very few previous studies of the spawning habits of *Sicyopterus* have been made. Most of these previous accounts were passing comments or records of random faunistic notes. Herre (1927) made the following remark in his review of the Order Gobiodea of the Philippines and the China Sea: "Although authors state that 'they are confined to fresh water near the sea' they really go down to the sea to spawn in common with many other fresh-water gobies". Montilla (1930) and Blanco (1938) also gave similar observational notes with regard to the spawning habits of some other related species in their surveys of the ipon fisheries of Ilocos and Cagayan Provinces, respectively. The general consensus of reports of these workers was that from August to February, *Sicyopterus* and other species successively make their way down to the sea to lay their eggs, and from about the middle of September to March, vast shoals of tiny, colorless gobies make their appearance at the mouths of Philippine rivers, especially in northern Luzon. Deraniyagala (1937), in his description of a related species, *Sicyopterus gymnauchen* of Ceylon, also reported this parallel phenomenon regarding the catadromous habit of the fish.

Annandale and Hera (1925), in their description of *Sicyopterus garra,* from streams of the Andaman Islands, noted among other things the peculiar mode of feeding of the adults, which consists of scraping organic matter and minute algae on the surface of rocks to which the fish adhere tenaciously with their ventral suckers. Herre (1927) also gave vivid account of the habitat and feeding habits of adults *Sicyopterus.* He says:

> These dull colored inconspicuous fishes abound in boulder-strewn mountain streams where the current is moderately swift. They love to lie above large rocks where they bask in the sunshine, protected by a shallow stratum of rippling water. Here they nibble at minute algae, ready to slip out of sight beneath the boulder at the first movement made by man or bird ..... In both Mindanao and Luzon, they ascend to an altitude of 1,000 meters or more.

THE PROBLEM

The commercial importance of the goby fry fishery which has been observed both by the fishermen and fish traders alike to be on a continuous decline led to the preliminary investiga-

tion of the fishery in the early part of 1937. In 1938, a more vigorous and intensive study of the various phases of the life-history and habits of the commercial species forming the fishery was undertaken in Cagayan River, Oriental Misamis Province, a typical and one of the more important goby-fry producing centers in the Philippines. This study was prosecuted with the purpose of answering the following questions:

1. What are the species forming the goby fry fishery in Cagayan River?
2. When does *Sicyopterus extraneus* (anga) spawn?
3. How frequently do they spawn?
4. At what size does the first spawning occur?
5. What are the spawning habits of the fish?
6. What is the embryonic development and early larva of *S. extraneus?*
7. When does the periodic appearance of the fry take place, and what is the duration of the runs of goby fry?
8. What are the food and feeding habits of the adult (anga)?

The present paper attempts to answer these questions insofar as the evidence gathered by the writer shows.

The data presented have been obtained for the most part from field work done and collections made by the writer, especially in the upper Cagayan River, Oriental Misamis Province. In addition, samples were also taken from the commercial hauls of fishermen operating in the mouths of Cagayan and Tagoloan Rivers of the same province. The collections of adult specimens were also gradually augmented by the specimens taken from the different commercial fishing operations along the Cagayan River.

Two measurements of length were taken in the examination of the fish. They are the total and the standard lengths. The latter, which was measured from the tip of the snout to the base of the caudal fin, has been used throughout the paper, unless otherwise stated. The total or over-all length was measured from the tip of the snout to the tip of the longest ray of the bluntly rounded caudal fin. All measurements were recorded to the nearest millimeter. Other methods used in the different parts of the investigation are described under the sections dealing with these phases of the work.

ACKNOWLEDGMENT

The writer is under obligation to a number of persons who have contributed in various ways during the investigation as

well as in the preparation of the manuscript. This investigation was conducted under the auspices of the Division of Fisheries, Department of Agriculture and Commerce, Manila, Philippines, of which the writer is a member of the staff.

Mr. Genaro Lopez, laboratory helper, and Mr. Rufino Hanginan, collector, both have done a good part of the collecting of the necessary materials used in this study. For constant encouragement and never-flagging guidance during the course of the investigation, the writer is deeply indebted to the late Dr. Hilario A. Roxas, then Chief of the Division of Fisheries, and to Dr. Deogracias V. Villadolid, then technical assistant of the same office. Dr. Lionel A. Walford, of the U. S. Fish and Wildlife Service, also aided in the interpretation of some of the results during the preparation of the manuscript. Professors George S. Myers and Willis H. Rich, both of the Stanford Natural History Museum, read the manuscript and offered constructive criticisms and suggestions. To all these persons who were helpful in many ways, the writer is grateful.

I. THE COMMERCIAL FISHERY

FISHING SEASONS

Unlike most other fisheries in which the adult forms are usually exploited, in the goby fishery the fry or juvenile stages constitute the principal catch. The adults of this group of fishes, which are generally confined in the boulder-strewn and rocky or pebbly beds of the upper streams of Cagayan River, are seldom, if ever, taken in any quantity. Most of this insignificant number taken are utilized for household consumption by river-bank inhabitants. When the adults are fished for, they are usually taken during the period from December to March, because at this time most of them are egg-bearing, consequently, they are fat and more palatable than when they are taken at other seasons of the year.

The fishing season of the goby fry may be classified into two periods, namely; the yearly (*panuig*), and the monthly (*bulan-bulan*). Fig. 1 shows the average monthly landing, expressed in number of cans [2] during the three-year period ending 1939. These catch data were based on five selected *baling* fishermen who had a complete record of catch for that period. A complete picture of the total landings of goby fry

[2] One petroleum can is equivalent to five gallons. This is the standard unit of catch used in the fishery equivalent to 15 kg. net weight of fresh fish.

cannot be presented here on account of the regretable fact that most fishermen do not keep any record of catch, either through lack of interest, or to evade any possible taxation. However, it has been estimated that the total annual landings in Cagayan River alone is between 40 and 50 thousand cans.

Despite this limited data on hand, the "monthly" and "yearly" fishing seasons were easily differentiated on the bases of number of landings and duration of the "migration run". It may be seen in the foregoing figure that the yearly fishing period extends from about the middle of January until the end of March, the season commencing earlier or later depending upon the lunar period. (This lunar fishing period of the goby fry is discussed more fully under the topic "periodicity and duration of the goby fry runs.") However, the peak of fishing activity occurs in February. These three months, January through March, cover the yearly or principal fishing season which the fishermen call *panuig* (literally, yearly), and the rest of the season, *bulan-bulan* (literally, monthly).

In other parts of the Philippines, as in the north and northwestern parts of Luzon, the principal fishing season appears to be protracted, extending from October through March (Herre, 1927); Montilla (1931), and Blanco (1938). No mention of distinction or occurrence of the two seasons, was, however, made by the aforementioned authors. In the other goby-fry-producing regions of northern Mindanao, it was observed in an earlier report (Manacop, 1940) that the principal fishing season may be short or prolonged from one to two months, depending upon the extent of the fisheries, or indirectly upon the size of the rivers where the fishery is found to exist.

Although it cannot be demonstrated here that the size of the rivers has some correlation with the magnitude and seasonal duration of the fisheries, it seems probable that the yearly season is more prolonged in large rivers than in small streams. The fact that larger rivers, under normal conditions, can sustain a larger fish population than the small ones because of more extensive living space, it appears to be a logical assumption that the larger space, will show more spread in spawning.

FISHING AREAS

The goby fry are caught in or near the mouths of rivers and all along their banks and shallow portions, and toward their sources or head waters. In Cagayan, Oriental Misamis, the fishing areas extend from two to three miles on both sides

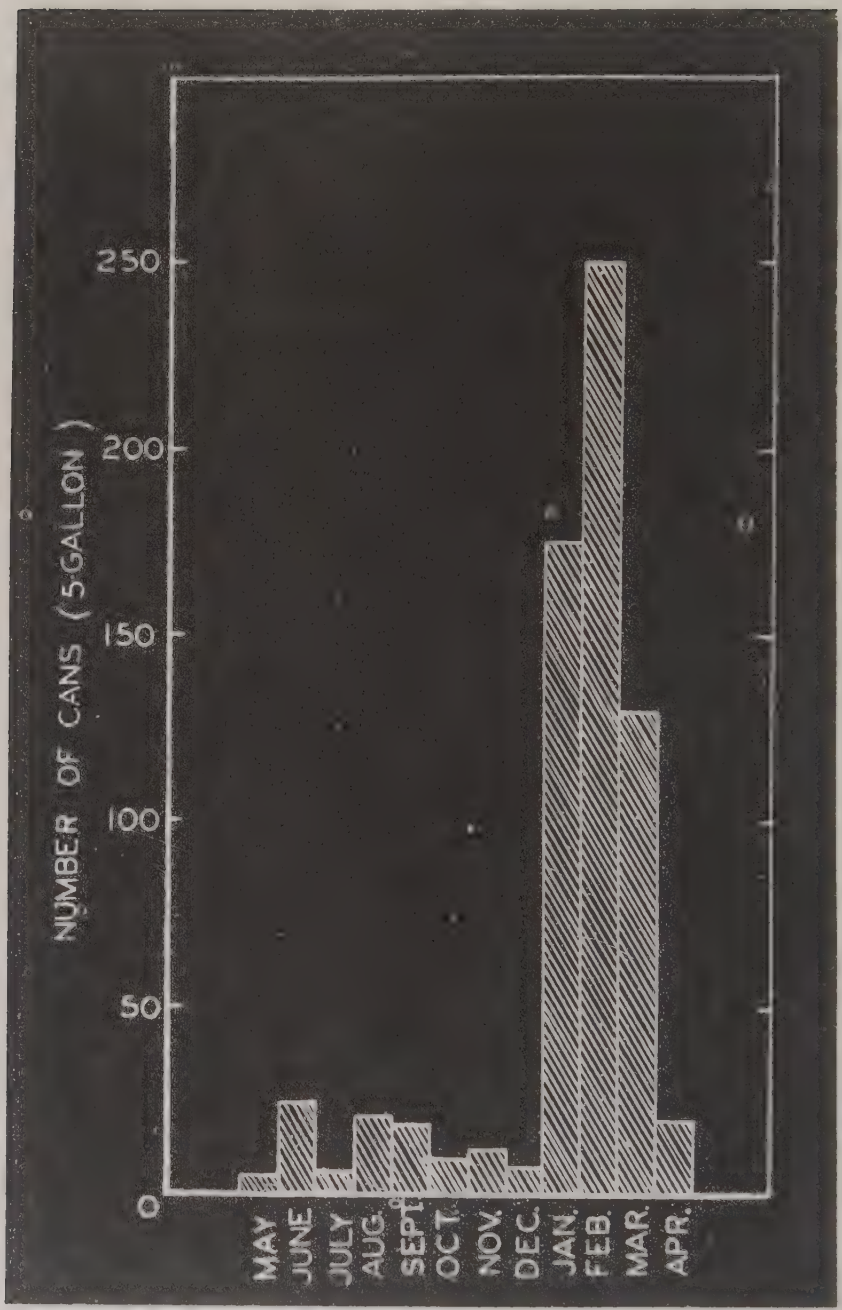


FIG. 1. Average monthly landings (1937–1939) in Cagayan, Oriental Misamis Province (data based on 5 baling outfits).

of the mouth of Cagayan River. When the goby fry start their upstream migration, the commercial fishermen do not usually catch them inside the rivers, except a few river fishermen, who generally fish for the fresh-fish markets.

PREPARATION OF THE CATCH

The bulk of the goby fry catch is pickled in table salt, fermented, and packed in air-tight 5-gallon tin containers. This salted fish paste (*guinamus* in Visayan, or *bagoong* in Tagalog and Ilocano) is prepared simply by mixing two parts by volume of table salt and five parts of fish. The mixture is then allowed to ferment for a few days in the packing containers (5-gallon cans or earthen jars) after which it is packed by soldering, in the case of the cans, and by covering the mouth of the earthen jars with cheesecloth. In Cagayan, Oriental Misamis, the use of earthen jars for packing and fermenting has been totally replaced by the 5-gallon tin cans (empty petroleum or gasoline cans).

After three to five months or so, the salted fish paste is considered to be "ripe" and ready for the table. It is, however, generally claimed by fishermen and fish traders that the longer the curing process the better is the quality and flavor of the product. In other words, as in the curing of wine, the quality of the product improves with age. The *bagoong* is either eaten raw with a sprinkle of lemon juice, or fried with fresh tomatoes. But it is often served as a sauce or condiment with boiled vegetables, meat or fish, and, of course, with the common staple food—rice or corn. Among the majority of the laboring class, this *bagoong* generally supplies the necessary animal protein. The by-products of bagoong, such as *heko* and *patis* (kinds of fish sauce) are, however, becoming popular among the more fastidious Filipino epicures.

FISHING METHODS

As in other parts of the Philippines, the goby fry in Cagayan River are caught by three general types of fishing gear, namely, (1) beach seine (*baling*), (2) scissor nets, and (3) fish barricades (*golgol*). Of the three types of gear, the beach seine is the most important, for it contributes the major portion of the commercial haul of goby fry that is salted and fermented. The other types of fishing gear are of minor importance, and cater only to the fresh-fish markets of the locality.

In the ipon fishery of northern Luzon, however, all the above-mentioned types of gear are extensively used in the commercial fishery. Here the fishery is exploited not only while the fish are in the sea, but also when they enter and ascend the fresh-water streams. Consequently, a more extensive and apparently more destructive method of exploitation of the fishery is being prosecuted in northern Luzon than in northern Mindanao. Such a situation is to be expected because of the demand on the fishery, brought about by the increasing density of population in the northern part of Luzon, especially along the Ilocos regions.

Beach seine (*baling*).—This fishing gear is generally used in any kind of fishery—for catching young sardines, anchovies, teuthids, and other larval fishes. The baling outfit consists of a net proper (*baling*), a mother vessel (*balingan*), and a small dugout for scouting (*manungdaan*). The balingan, with a capacity of 2 to 3 tons gross, is operated by 15 to 25 men, usually 20, the number depending upon the size of the outfit. This vessel, which is provided with outriggers on both sides and a landing platform for the net amidship, is not powered, but is provided with racks for oars and a lateen sail for navigation when necessary. Because most of the fishing operation is carried on close to the shore, usually within the 1-mile limit parallel to the general coastline, the employment of powered vessels becomes unnecessary. The scouting dugout (manugdaan), which is usually operated by one man, serves both for fish scouting and as a "skiff-end" of the net during the actual fishing operation.

The net proper consists of a rectangular curtain of fine-meshed [3] webbing of woven abaca cloth (product of *Musa textilis*), with a length of 300 to 400 feet, and a depth of about 6 feet at the wings to about 18 feet at the central portion (bunt). It is provided with a conical bag, 30 feet long, flanked by two converging wings on both sides. The ends of the wings are provided with wooden brails for spreading the net and for convenience in hauling-in operation. The upper selvage of the net is provided with wooden floats, and the lower with lead weights, studded at about a foot interval. In actual operation, the net is laid out in a semicircle, and then the two brail ends and wings are hauled to the shore until the fish are im-

[3] In the wings about 8 threads to the inch; in the bag, about 25 threads to the inch.

pounded in the sack or bag. For detailed construction and mode of operation of the net, reference should be made to previous reports of Montilla (1931), Umali (1934), Talavera and Montalban (1932), and of Manacop (1940).

The adult anga and other gobioid fishes of the mountain streams are taken by special kinds of fishing gear. These are: (1) cast net (*taclob*); (2) fish barricade (*golgol sa anga*); and (3) spear gun (*pusil-pusil*).

Cast net (*taclob*).—The cast net is the most handy and effective fishing gear used in catching these wary and agile fishes. It is a diminutive replica of the age-old conical cast net which is operated on the same principle. This net has a diameter of about 60 centimeters when stretched, with the lower selvage studded with globular lead sinkers, and with seamed pockets or bags along the inside edges. It is simply operated by casting it with the right hand, aided by the left hand, to make a perfectly circular throw. The net is operated in water 6 inches to 2 feet in depth in those portions of the streams where the current is moderately swift. After every cast of the net, every loose stone enclosed by it is overturned in order to drive the fish into the pockets.

Fish barricade (*golgol sa anga*).—This gear consists of a triangular barricade of stones and coconut leaves, set somewhat parallel to the direction of the current of the stream, where the water is about a foot deep. Once the gear is set, the fish are driven into a previously set bag at the apex of the barricade by turning over all loose stones within the inclosed area. The driving of the fish continues to the mouth of the landing bag after which the mouth is immediately lifted, thereby impounding the fish.

Spear gun (*pusil-pusil*).—This is an improvised wooden gun that is operated on the principle of a sling, using a sharpened $\frac{3}{16}$ inch iron spear as the projectile. Strands of rubber bands (taken from an inner tube of an automobile tire), ingeniously rigged on the gun, give the necessary driving force to the spear. Similar spear guns used by sea bathers are now becoming common sights along beach resorts in many places, where their use has become a popular aquatic form of recreation. To be effective, this method of fish spearing must be aided by the use of a pair of good water-goggles, which insures good vision under the water.

II. SPAWNING

SPAWNING SEASON

In order to ascertain approximately the spawning season of *Sicyopterus extraneus,* extensive examinations of the gonads of all fish taken were made in every fortnightly sample. Most of the fish examined were specially collected for the purpose, since, as stated in the early part of this paper, the adults do not usually enter the commercial catch of the fishermen. These materials were further augmented from samples taken from the catch of fish barricades (*bisig*) in the upper Cagayan River. The following results were obtained from 3,345 adults and several thousand young taken from January, 1938 to August, 1940, inclusive.

DESCRIPTION OF THE GONADS

Female.—After examining a large number of females, three following developmental stages were observed to be clearly marked: (1) Immature stage; (2) intermediate or early maturing stage; and, (3) mature or ripe stage. For the determination of the spawning season, discussion of the development of the last two stages of the ovary will be given more emphasis.

1. *Immature stage.*—This is the primordial or immature stage of the ovary which is characterized by the presence of only immature, undeveloped ova, measuring from 0.00 to 0.038 of a millimeter in diameter. This is an infallible sign of sexually immature females. These tiny, creamy ova appear transparent white in preserved material (in three per cent formaldehyde) and are held together by the connective tissue of the ovary. The ova, which on account of their minute size are visible only under a compound microscope, do not impart the granulated appearance to the ovary which are indicated in the later stages.

2. *Intermediate or early maturing stage* (*Plate 1, fig. 1*).—The presence of intermediate or early maturing groups of eggs is a sign of approaching maturity and indicates that spawning will take place in the subsequent spawning run. This stage appears to be analogous to the intermediate stage of the ovary as found by Clark (1925) in *Leuresthes tenius*; Mane (1929) in *Arius* spp.; Villadolid and Manacop (1934) in *Gulaphallus mirabilis;* and by other workers in different kinds of fishes with a prolonged spawning season. The occurrence of this group of eggs apparently has some relation to the prolongation of the spawning season, as will be seen in the latter part of the discussion under this topic. These intermediate eggs measure

from 0.053 to 0.203 of a millimeter in diameter. They distinctly differ from the immature eggs from which they have been derived by being more opaque in appearance. At this stage also, the characteristic gelatinous threads begin to develop. These first appear as short strands of threads, presumably differentiated from the cell walls, and later gradually increasing in length and number over the surface of the egg. Eggs preserved in three per cent formaldehyde appear slightly orange, and they impart a somewhat granulated appearance on the external walls of the ovary. These groups of eggs are still held together by the connective tissue of the ovary.

In the advanced intermediate stage, the eggs appear more or less translucent toward the periphery, but remain opaque centripetally. The rapid increase of the maturing group of eggs which now become visible to the naked eye, imparts a distinct granulation to the ovary walls. The gelatinous threads, which by this time have also become fully developed, appear to be closely wound around the eggs in a more or less labyrinthine arrangement. The large and numerous oil globules of the eggs also become discernible at this stage, especially in freshly mounted specimens.

3. Ripe stage (*Plate 1, fig. 3*).—At the approach of maturity the ripe eggs lose their opacity and become distinctly translucent and yellowish-orange in color. They measure from 0.248 to 0.368 of a millimeter in diameter. The ovary which has greatly increased in size, brought about by the ripening and enlargement of the maturing eggs, now occupies almost two-thirds of the abdominal cavity (Plate 2, fig. 1). At this stage also the ovary becomes distinctly lobulated. The ripe eggs become loosened from their attachment with the connective tissues of the ovary and become lodged in its lumen, preparatory to oviposition. The characteristic gelatinous threads enveloping the eggs become loosely unwound and when the belly of a ripe female is pressed, ripe yellowish-orange eggs ooze out from the genital opening.

Males.—On account of the difficulty of determining the different development stages in the male, the mature spermatozoa, being minute, were simply classified as immature and mature. The testis of a sexually immature male is so fine and thread-like that it is often overlooked in the examination of the gonads. As sexual maturity approaches, the testis becomes less firm and somewhat lobulated. When a portion is teased out on a slide and examined under a compound microscope,

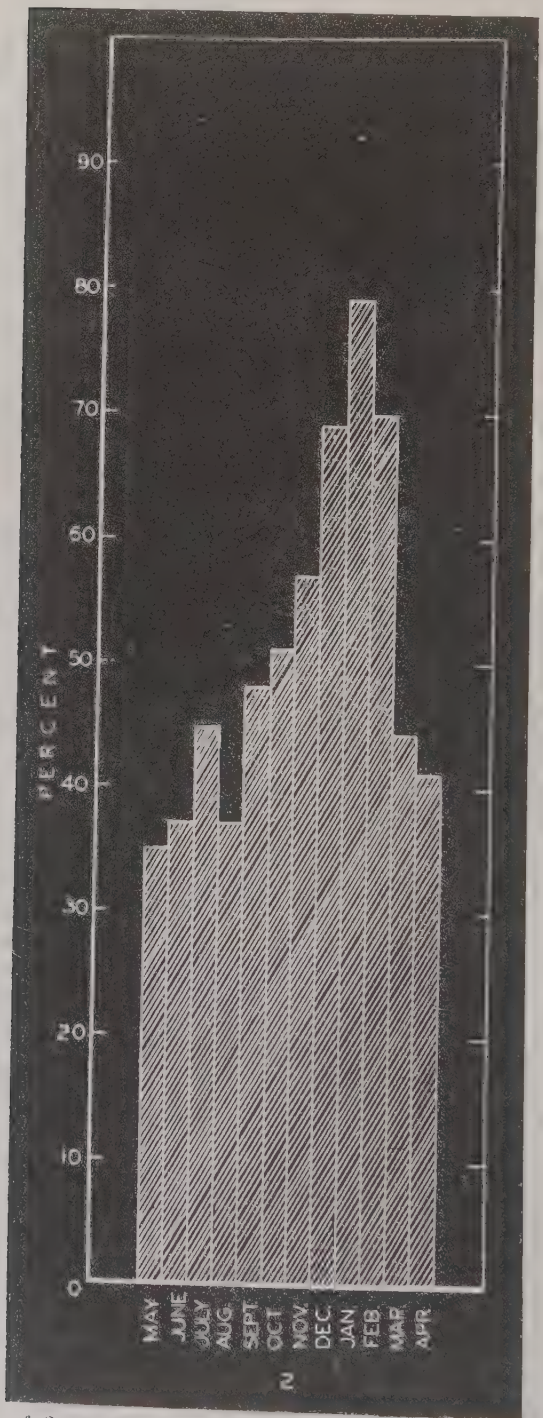


FIG. 2. Summary of *Sicyopterus* spawning season in Cagayan River as indicated by the percentage relation between spawning females and all females.

actively swimming spermatozoa become discernible. Externally, the mature males were easily distinguished from the immature by the appearance of oozing milt from the genital opening when pressed.

DURATION AND PEAK OF THE SPAWNING SEASON

The results of the examination of a large number of females undertaken throughout the three-year period of investigation showed that the anga spawns almost every month throughout the year, with varying percentages of actually spawning females every month (Table 1, text fig. 2). This continuity of spawning activity is evidenced by the finding of spawning females in every monthly sample. It was observed that a minimum spawning activity occurred in May when only about 35 per cent of all the females examined during the month were found in spawning or maturing condition. Since then the percentage of spawning females gradually increased as shown by the rising graph with some minor fluctuations in July and August, and finally attained its maximum in January when about 79 per cent of the total number of females examined were in spawning condition. In February, spawning activity seemed to abruptly decrease until April when only about 41 per cent were found in spawning condition. These varying percentages of the spawning activity seem to indicate definite "spawning groups" in the entire population which spawn every month. However, it was not definitely ascertained whether one spawning group that spawn this month will spawn the following month.

The principal spawning months extend from December through February, covering a period of about three months, apparently coinciding with the early part of the dry season months, while the minimum months, May and June, cover the commencement of the rainy season in Cagayan regions. As a general rule, the principal spawning period of most Philippine fishes occurs during the warmer months of the year (February through April).

The other evidences of the continuity of the spawning activity of anga are: (1) the simultaneous occurrence of intermediate and mature groups of eggs in the samples of mature females examined every month throughout the year; and, (2) the periodic appearance of hipon runs every month throughout the year.

The occurrence of a prolonged or a continuous spawning season is not an unusual phenomenon in tropical fresh-water

fishes. Mane (1934) reported a similar condition in *Mesopristes plumbea* of Laguna de Bay. In *Gulaphallus mirabilis* of Molawin Creek, Laguna Province, an almost identical phenomenon was also observed (Villadolid and Manacop, 1934). Fulton (1899) in his classification of teleostean eggs, as cited

TABLE 1.—*Percentage of female anga with maturing or ripe eggs in monthly samples, collected from January 18, 1938 to March 24, 1940.*

Date	Total number	Number mature	Per cent mature
January 18, 38	45	45	
January 9, 39	82	62	
January 21, 39	102	84	
January 22, 40	114	82	
Total	343	273	79.30
February 4, 38	98	70	
February 12, 38	88	72	
February 16, 39	80	56	
February 25, 39	98	68	
February 7, 40	116	70	
Total	480	336	69.99
March 9, 38	78	46	
March 9, 39	114	52	
March 10, 40	86	30	
March 24, 40	90	36	
Total	368	164	44.63
April 26, 38	98	42	
April 18, 39	86	33	
April 30, 39	128	62	
April 25, 40	88	28	
Total	400	165	41.25
May 2, 38	112	41	
May 19, 38	80	27	
Total	192	68	35.20
June 5, 38	84	26	
June 27, 38	102	42	
June 17, 39	108	44	
Total	294	112	38.09
July 5, 38	188	36	
July 27, 38	102	42	
July 14, 39	86	28	
July 22, 39	92	60	
Total	364	166	45.60
August 7, 38	112	34	
August 17, 38	73	31	
August 25, 39	65	29	
Total	250	94	37.60
September 9, 38	88	36	
September 18, 38	90	56	
September 28, 38	110	48	
Total	288	140	48.61
October 10, 38	102	66	
October 26, 38	110	35	
Total	212	111	51.41

by Clark (1925), states that the presence of the intermediate group of eggs is almost always associated with a prolonged spawning season.

SPAWNING AND FISHING SEASONS

Figure 3 shows the relation between the fishing season and spawning seasons of anga. The data on the spawning season are shown as a histogram in terms of percentages of spawning females for each month. Superimposed on this graph is one of the monthly catch in terms of the number of cans. This graph shows that there is apparently a close association between the spawning and fishing seasons. The principal spawning months extended from December until February, and this period almost coincided with the fishing season with the latter commencing and closing a month later. However, the peak of spawning activity occurred in January and that of the fishing activity a month later—February.

The biological significance of this difference of a month between the peaks of spawning and fishing seems to show that the young hipon fry entering the commercial haul are probably about a month old. In other words, the hipon fry that appear in the February "run" are presumably derived from eggs laid sometime in January, and those hipon fry runs in subsequent months which appear in the river shores with almost precise regularity every four weeks were probably derived from eggs laid a month earlier.

After the principal spawning months, the spawning activity of anga declined to a range of from 35 per cent in May to about 57 per cent in November. A similar decrease in the fishing activity likewise followed, although the catch in every month did not correspond closely with the fluctuation of the monthly spawning activity. This may be due to some biological factor or factors affecting the rate of mortality. However, there is one thing that is quite significant in the graph, that is, a decrease in spawning activity seems to be followed by a similar decrease in fishing activity and in yield.

FREQUENCY OF SPAWNING

While a detailed study of the history and development of the different stages of the ova was not undertaken in the present investigation, there is some evidence that each individual anga spawns more than once throughout the year. This is shown by the following: (1) the simultaneous appearance of the three

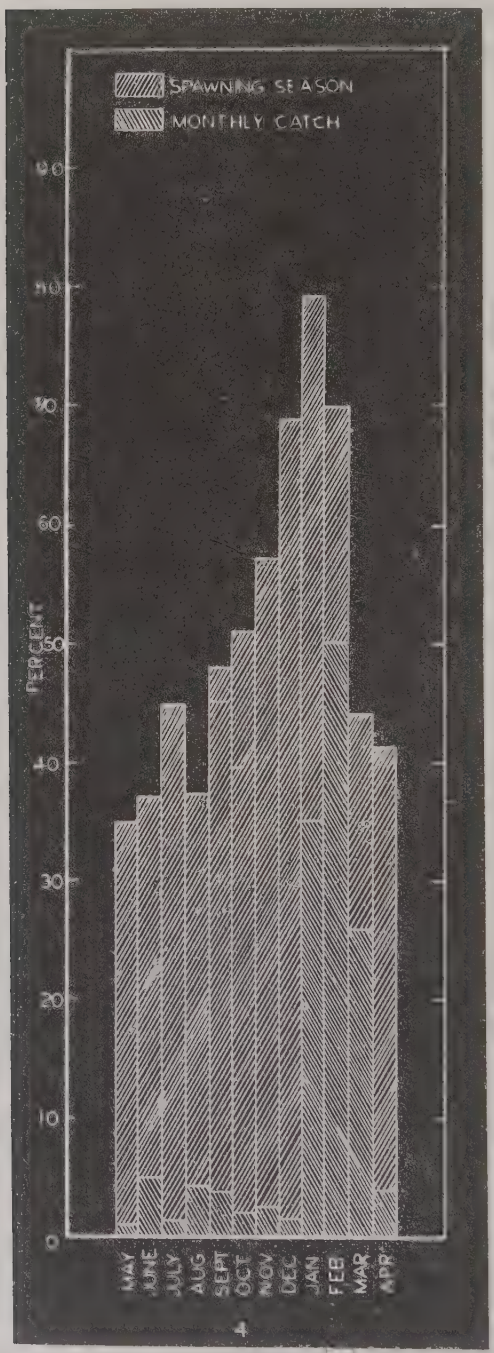


FIG. 3. Comparison between the monthly catch and the spawning season.

groups of eggs, namely, immature, intermediate, and mature—in mature female fish at all times throughout the year; (2) the regular periodic runs of goby fry about a month old at approximately twenty-eight day intervals almost throughout the year.

This apparently multiple spawning habit of anga, although it may appear unique, is not at all an unusual occurrence in fishes. Parallel phenomena have been reported in a number of other species of fish, such as in *Leuresthes tenius* (Thompson, 1919a and 1919b), reaffirmed by Clark (1925); in *Atherina californiensis* (Clark, 1929); and in *Arius* spp. (Mane, 1929). Among these fishes, the most striking multiple spawning phenomenon is exhibited by *L. tenius,* the fish with tide controlled spawning habits (Clark, 1925). But since the anga spawns in the upper streams, the tide factor cannot be associated with its spawning habits. However, there appears to be some apparent association of the tide with the frequency and periodic appearance of the goby fry runs, as will be seen under the discussion of this topic.

Further and conclusive evidence with regard to the multiple spawning habit of anga is provided by the fact that by the time one intermediate or maturing group of eggs attain maturity, a new batch of the early intermediate group of eggs, differentiating from the upper size limit of the immature group, becomes evident (figs. 4*a* and 4*c*). In recently spawned, or "spent," fish, as well as in ripe ones, this early intermediate group of eggs is clearly shown. In a graph it appears as a mode centered at an egg diameter of about 0.068 millimeter. This group of eggs continues to increase in size and dispersion until it becomes a distinct, homogenous group, developing at an apparently accelerated rate towards maturity. This distinctly differentiated intermediate group consists of eggs measuring from 0.098 to 0.203 of a millimeter in diameter. The rate of transformation of the immature group of eggs to the intermediate and from the intermediate to complete maturity was not definitely ascertained, although it is presumed to be rapid as indicated by the breaks in the continuity of the frequency histograms of ova taken from intermediate and mature females.

There is a probability that, during the principal spawning months extending from December to February, an individual female fish may spawn more frequently than during the other months of the year. The occurrence during the principal fishing

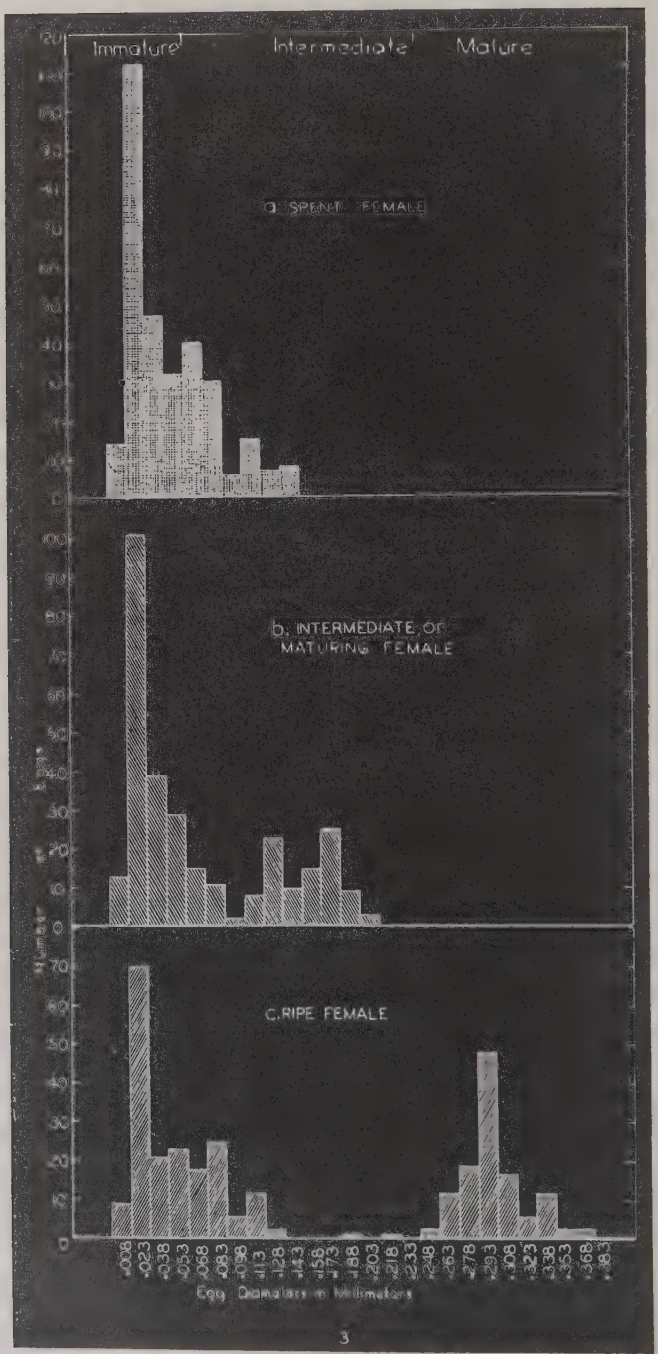


FIG. 4. Diameter frequencies of 300 ova, each taken from the three developmental stages of the ovary, all collected on August 21, 1940, from Cagayan River; (*a*) "spent" female, 7.4 cm. long; (*b*) intermediaite or early maturing female, 7.3 cm. long; and (*c*) ripe female, 6.9 cm. long.

season of the two to three distinct batches[4] of goby fry in every monthly run and of about 69 to 79 per cent of ripe fish among the mature females indirectly substantiates this assumption of more frequent spawning. During the other months of the year, when there usually occurs only one batch of goby fry in the monthly run, it seems plausible that a single female may spawn only once in a month, skip for a month or so and then resume spawning. This presumption is supported by the following evidence: (1) About 35 to 50 per cent of the females examined were in actual spawning condition during the rest of the year, outside of the principal spawning months; (2) "Spent" and actually spawning females were found simultaneously in every sample collected in every month throughout the year; and, (3) "spent" females were found in varying degrees of "spentness". Those which were found partly "spent" may spawn the second or third batch in the run of the same month, and those almost fully "spent" and showing an apparently rapid development of the intermediate group of eggs may spawn the next month or later.

PERIODICITY OF SPAWNING

The available data strongly suggest, although they are inadequate to prove, that there is a definite monthly cycle in the spawning of the population of anga. First, the periodic appearance of the hipon fry runs, which occur at almost every twenty-eight day interval, shows that the fish must have spawned periodically a month previous. If spawning were not periodic, there would not be this periodic appearance of almost one-month-old fry at every definite lunar period (fig. 10).

It will be seen further in fig. 10 that a more regular periodic appearance of the hipon fry runs was observed during the principal spawning months than during the other months of the year. This phenomenon may possibly be related to the fact that a much higher percentage of the females are in spawning condition at this time (69 to 79 per cent) than at other times (35 to 50 per cent). Efficiency may be increased by concentration of the spawning activity.

SPAWNING HABITS

The question as to where the anga and its close relatives of the same family spawn has been the subject of much con-

[4] A batch is a shoal of goby fry hatching from the same batch or group of eggs laid at almost the same time.

troversy among fishery biologists and ichthyologists who have worked in one way or another on this group of fishes. It has been the general claim that, although they are "confined to the fresh-water near the sea, they really descend to the salt water to spawn". This is the opinion expressed, among other things, in the reports of Taylor (1919); Herre (1927); Montilla (1931); Blanco (1938); and Villadolid and Blanco (1939) in their observations on the goby fry fisheries of the north and northwestern parts of Luzon. Deraniyagala (1937) came to the same conclusion in his observations and description of a related species, *Sicyopterus gymnauchen*, in Ceylon, India. The claims of these workers are not, however, in accord with the observations of the writer, which show clearly that spawning occurs in fresh water. The finding of the breeding grounds as well as the eggs in the upper streams, and a complete knowledge of the early life history, are conclusive evidence on this point. It may be possible, however, that the species studied by the foregoing workers are really catadromous, but it is very doubtful that these closely related species, under practically the same tropical conditions, would exhibit such different spawning habits. The collection of some specimens of the adults of this group of fishes in salt waters, as well as the regular appearance and upstream migration of the goby fry in a similar fashion as those of the other known catadromous fishes as reported by these previous workers, cannot fully substantiate their claim that these fishes are really catadromous. It cannot be denied, of course, that during heavy freshets some of the adults in the upper reaches of the streams are liable to be carried down to the sea. Normally, however, they spend their existence in fresh water, letting only their eggs and larvae be washed down by the river current to the sea, and later, after attaining a certain stage, the fry return "home", so to speak.

The fresh-water spawning of the anga is not an unusual occurrence in the family Gobiidae. As a matter of fact a similar phenomenon is known to occur in the other members of the same family, such as the common white goby *Glossogobius giurus*, of Laguna de Bay, Luzon and of Lake Mainit, Mindanao; *Mirogobius lacustris* of the first-named lake; *Mistichtys luzonensis* of Lake Buhi, Camarines Sur Province, Luzon, and a number of others. Those fishes, which are apparently geologically recent migrants from salt water, evidently spend their whole existence in fresh water.

SPAWNING GROUND

The female anga was observed to spawn in varying depths of water, from half a foot to about four feet, with the largest fish apparently preferring the deeper places, and the smaller ones, the shallows. Like the Pacific salmon (*Onchorynchus*), the fish prefers to spawn under gravel and loosely set stones in the shallow, swift, upper reaches of the rivers. However, the eggs of *S. extraneus* are not buried in the sand as in the case of the salmon. As a matter of fact, during the extensive collection of eggs for embryological study, the writer frequently found batches of newly laid eggs in these preferred portions of the stream, and seldom, if ever, were found in the still portions. There seems to be an obvious reason for such a preference, as will be seen in the discussion of the fate of the newly laid eggs.

The actual procedure of laying the eggs on the undersurface of the loosely set stones was not observed. It is, however, presumed that the female anga, when ready to spawn, wriggles under a loosely set stone. As the fish holds fast to the under surface of a stone with the aid of the ventral sucking disc, the eggs are spread into a flat mass (Plate 2, fig. 2). As the eggs are extruded their gelatinous threads covering them adhere to the undersurface. Fertilization undoubtedly takes place externally, with the male probably following the spawning female and ejecting his milt on the mass of eggs.

No conclusive indication of parental care over the newly laid eggs was obtained. However, the information of experienced anga fishermen, including the collector for the writer, was that both parents seem to watch their eggs after laying and probably until the eggs are hatched. It is not an uncommon occurrence to find paired fish under a stone bearing eggs or likely "nesting" place.

REPRODUCTIVE CAPACITY OF AN AVERAGE-SIZED FEMALE

To estimate the number of eggs produced in one spawning, a maturing ovary of an average-sized female (6.6 centimeters long) was preserved in five per cent formalin solution. The whole ovary, after being removed from the fixing solution and the excess moisture drained off, was weighed to the nearest milligram. Following this procedure, the middle portion of the ovary was taken and weighed to the nearest milligram. The number of maturing eggs in the lot was then counted and the resultant number multiplied by the entire weight of the ovary.

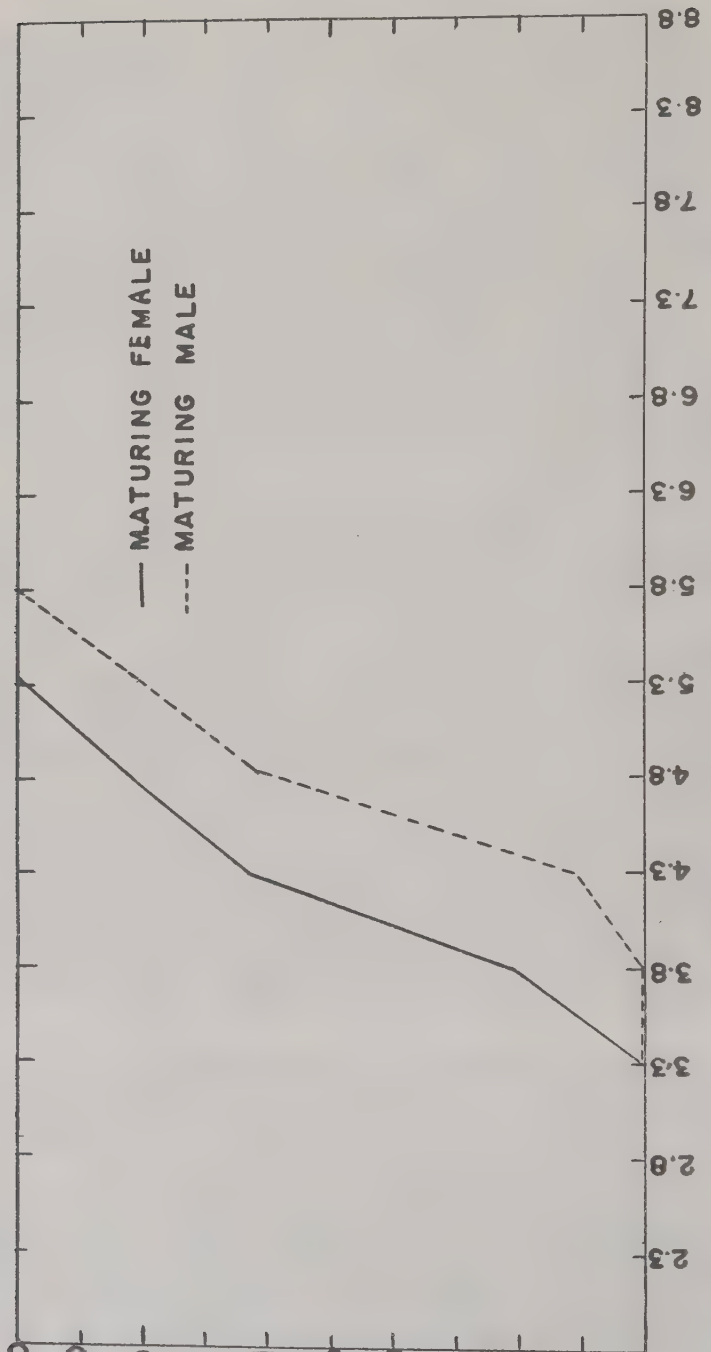


FIG. 5. Showing the sign when maturity occurs. The solid line represents the percentage of maturing females and the broken lines the percentage of males which mature at the indicated sizes.

With this procedure, the approximate number of maturing eggs contained in the whole ovary of the average-sized female was estimated at no less than 46,000.

SIZE AT FIRST SPAWNING

In determining the size at sexual maturity, the gonads of all adult fish were examined and their condition of maturity ascertained. In the females, the presence of intermediate, mature or ripe eggs was used as a criterion to indicate the sexual maturity of the fish. In the males, however, the presence of milt and the advanced development of the testes were considered signs of sexual maturity.

Table 2 shows the results of these determinations which are graphically illustrated in fig. 5. Of the 2,764 females examined, 2,631 were found sexually mature and 133 immature. The smallest mature females were found in the size group from 3.6 to 4.0 centimeters long, in which about 20 per cent were found sexually mature. However, the minimum length of actually spawning females was found to be about 4.0 centimeters. About 61 per cent of the females of the size group of 4.1 to 4.5 centimeters long and about 81 per cent of 4.6 to 5.0 centimeters were mature. All fish examined above 5.1 centimeters long were found to be sexually mature.

TABLE 2.—*Size groups of sexually mature anga.*

Body length	Female				Male			
	Mature		Immature		Mature		Immature	
cm.	*Number*	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*	*Number*	*Per cent*
2.1- 2.5								
2.6- 3.0			8	100.00				
3.1- 3.5			21	100.00			22	100.00
3.6- 4.0	12	20.68	46	79.32			24	100.00
4.1- 4.5	52	61.90	32	38.10	5	13.16	33	86.84
4.6- 5.0	114	81.44	26	8.56	54	62.79	32	37.21
5.1- 5.5	256	100.00			90	80.35	12	19.65
5.6- 6.0	332	100.00			184	100.00		
6.1- 6.5	548	100.00			366	100.00		
6.6- 7.0	430	100.00			402	100.00		
7.1- 7.5	338	100.00			492	100.00		
7.6- 8.0	334	100.00			216	100.00		
8.1- 8.5	186	100.00			94	100.00		
8.6- 9.0	18	100.00			36	100.00		
9.1- 9.5	2	100.00			4	100.00		
9.6-10.0	0	00.00			0	00.00		
9.1-10.5	2	100.00			0	00.00		
10.6-11.0	4	100.00			4	100.00		
11.1-11.5	0	00.00			2	100.00		
11.6-12.0	1	100.00			4	100.00		
12.1-12.5	2	100.00			0	00.00		
12.6-13.0					1	100.00		
13.1-13.5					2	100.00		
13.6-14.0					2	100.00		
Total number	2,631		133		1,758		123	
Mean	6.602†	0.0208 cm.			6.82	0.023 cm.		

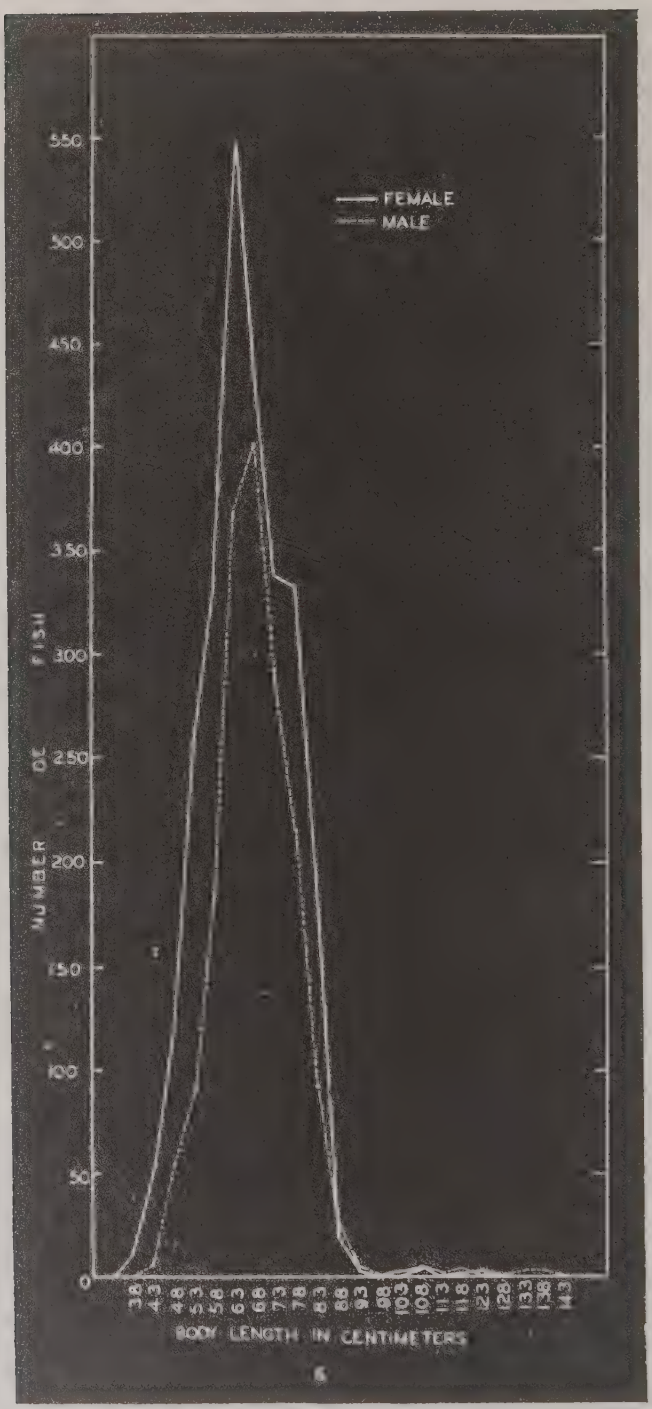


FIG. 6. Body length frequencies of males and female *Sicyopterus* (data based on all materials collected during the period of investigation).

With the males, out of 1,881 dissected, 1,758 were found to be sexually mature and 123 immature (fig. 6). As regards size, the males apparently are longer than the females at sexual maturity. About 13 per cent of the males in the group from 4.1 to 4.5 centimeters long were evidently mature as compared with 61 per cent in the females. About 62 per cent were found mature in the size group of 4.6 to 5.0 centimeters and 80 per cent at 5.1 to 5.5 centimeters. All males examined above 5.6 centimeters were found to be sexually mature.

It is evident from the foregoing discussion that in both sexes, as in most animals, the sizes of maturing individuals vary, starting from a more or less definite minimum and gradually increasing to a group in which all the fish are sexually mature. These variations may be the result of variations in food and other environmental factors, or they may be hereditary.

With regard to the determination of the age groups, some preliminary attempts in the examinations of the scales were undertaken, in an effort to find some indications of annuli. The scales were taken from behind the operculum of the fish and were mounted in dilute glycerine for examination. After examining a fair number of scales from fishes ranging in size from 3.0 to 4.0 centimeters long, some apparent markings or annuli were found, but there had been no opportunities to carry the study further. Only future study will show what these markings signify, whether they are breeding "checks" or annuli, each of indeterminate origin and significance.

III. SEXUAL DIMORPHISM

The anga presents a distinct sexual dimorphism, so distinct that even without examining the gonads, the sexes are easily separated. The males are characterized by the prolongation of the second, third, and fourth spines of the first dorsal fin, which in the females are not so well marked. The membrane almost extends to the tip of these prolonged spines. As a rule, the males have more slender and longer bodies than the females. In other respects, body coloration, scalation, and so forth, both sexes resemble each other in almost every detail.

Color in life.—The body in both sexes is marked by about 6 or 7 dark-gray transverse bars along the sides. These bars are wider than the interspaces, become indistinct toward the head region, but remain fairly distinct toward the caudal fin. In older specimens, these transverse bars become diffused and appear like dark-gray blotches along the dorsal and lateral parts

of the body. This may be so on account of the surrounding environment since the adults live under the big boulders and rocks in the river beyond the reach of constant sunlight.

A heavy spot, resembling a black teardrop, descends from the eye to angle of the mouth. Another wavy black line, crosses the interorbital space. In older specimens this heavy line, however, becomes a distinct skin fold, appearing like a wavy wrinkle or wart on the forehead. From this point toward the snout are scattered dashes of dark violet. The first and second dorsals are dark olive-brown, with numerous cross bars of dusky, brownish-violet lines or spots running diagonally downward and backward. The caudal fin is dull olive-violet, with its upper and lower margins yellowish-orange; anal fins, same color as body, with bluish margins like the caudal, ventral fins, yellowish, distinctly semicircular and adherent to the belly. The body scales are small and distinctly ctenoid. As a rule, the fin markings, especially those on the dorsals and anals, are more vivid in the males than in the females.

Morphological differences between the sexes.—As to body length, the males are comparatively longer [than the females, the average measurement being 6.82 ± 0.023 [5] centimeters and 6.30 ± 0.021 centimeters, respectively. The difference between the average lengths of the two sexes is highly significant, as is shown by the value of 6.7 for "t"][6] (see Simpson and Roe, 1939, and Table VI). As mentioned in the foregoing paragraphs, the most significant distinguishing characteristic of the male is the elongation of the second, third, and fourth spines of the first dorsal fin into long terminally free spines. In the males the average length of the longest spine, which may be either the second or third, seldom the fourth, is about 32.5 millimeters from the base. In the females it is about 26.0 millimeters long. This longest spine, when stretched over the middorsal toward the caudal fin, extends to about the sixth and seventh ray of the second dorsal fin in the male, and to the second and third of same in the female.

When in breeding condition, the bellies of the females are more round than those of the males, because of the ripening ovaries in the former. The genital papilla is long, slender, and bluntly pointed in males, and distinctly short, thick, and cylindrical or subglobose in the females.

---

[5] Standard error of the men.

[6] "t" is the ratio of the measure being tested to its standard error.

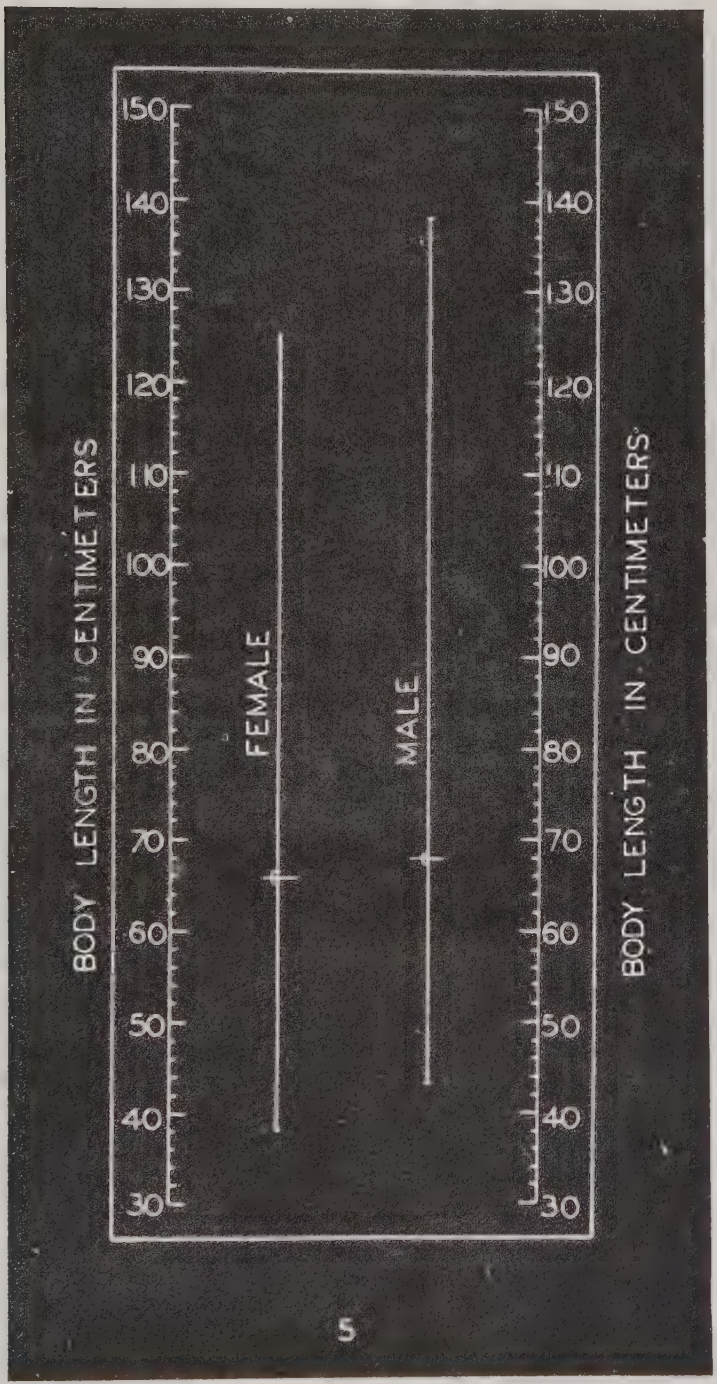


FIG. 7. Graphic estimation of the significance of the difference between the average body lengths of male and female *Sicyopterus*.

IV. EMBRYONIC DEVELOPMENT AND EARLY LARVAE

All attempts to artificially fertilize the eggs in order to secure the early embryonic stages failed. So, all the materials used in this study were collected directly from the spawning grounds and must have been naturally fertilized. The delicate eggs, which were firmly attached to the undersurface of stones, were removed without much injury by carefully scraping them off with a wet hen's feather. These eggs were then immediately transferred to glass jars and taken to the laboratory for study. They were kept in clean finger bowls and petri-dishes containing fresh river water. Constant aeration of the eggs was provided by the frequent changing of the water in the culture dishes during the incubation period. During this time microscopic examinations were made at frequent intervals to determine the changes of embryonic development (see Plate 1, figs. 1 to 17).

Newly laid eggs (*figs. 3 and 5*).—The newly laid eggs are demersal and are held together in a solid flattened, yellowish-orange mass by inter-twining gelatinous threads which adhere to the stone substrate. Upon closer examination each egg reveals the presence of tuft of these adhesive threads arising from the pointed pole of the egg. These threads appear neatly arranged within a calyxlike cap at this pointed pole of each egg. The specialized type of egg filaments, based on the classification made by Clark (1925), consists of a "specialization in the structure of the whole tuft of adhesive threads in which the filaments are arranged in a circle around one pole, united in a network the whole tuft forming a funnellike structure. Pagenstecher (1861) cited by Clark (1925), described fully the occurrence of this type of eggs, in *Atherina hepsetus*. A similar type of adhesive thread has also been observed in *Menidia menidia* by Hildebrand (1922). In *Gulaphallus mirabilis* and *G. falcifer* (Villadolid and Manacop, 1932 and Manacop, 1936, respectively) similar adhesive threads were observed and fully described, although in this form the gelatinous threads were decidedly few in number and comparatively longer, with their roots arising from different parts of the egg membrane.

The eggs are bluntly ovoid and highly transparent when examined singly under a microscope. The diameter of the newly laid eggs across the blunt end varies from 0.37 to 0.44 of a millimeter. The egg membrane is thin but fairly resilient. The yolk sphere contains from 60 to 80 oil globules of unequal sizes and numerous small ones scattered throughout the cytoplasmic mass. The translucent yolk mass bears the yellowish-orange coloring of the egg.

Fate of the newly laid eggs.—The eggs were observed to hatch in about 1 to 2 days under laboratory conditions. In repeated collections of eggs for embryological studies, it was observed that when the eggs are about to be hatched, they apparently become loosened from the stone. Upon closer examination of the eggs, it appears that the threads have gradually lost their gelatinous property, due possibly, either to degeneration or continuous washing by the currents of water that seep under the stone "nest". Consequently, when a stone bearing a batch of eggs at the hatching stage happens to be overturned, the swift rush of the river current immediately washes off the eggs and carries them downstream to the sea. Since this observation on the washing off of the hatching eggs by the river current was accidental, it is presumed that under normal conditions, the hatching eggs would remain under sheltered stone "nest" until they are completely hatched. When the newly hatched fry are able to swim they leave their stone "nest" and migrate downstream to the sea.

Further evidence in support of this presumption that the hatching eggs and newly-hatched fry are carried down to the sea is shown by the findings of these stages in the plankton hauls made in the lower reaches of the river during the peak of the breeding season (Table 3). As a provision of Nature, therefore, it is necesary for the female anga to lay her eggs in swifly flowing portions of the stream in order that they may be carried down to the sea—a normal phase of the life cycle. In the laboratory the newly hatched fry were reared until their yolks had been fully absorbed, but beyond this stage they began to die. Some fry hatched in the laboratory were placed in live boxes set out in salt water, but these also succumbed, due possibly to lack of food and absence of constant aeration in the live boxes.

Embryonic development.—The embryonic development of *S. extraneus* is typical of demersal teleostean eggs. The only notable difference lies in the rate of development and the differentiation of the various embryological stages. Although extensive collections of the naturally fertilized eggs were made, the early cleavage stages were taken and observed due to the rapid development of these early stages. Judging from the rate of development of the egg in the later cleavage stages, it seems probable that the earliest stage found was approximately 3 hours after fertilization.

Blastodermal cap stage (fig. 6).—The earliest embryonic stage collected was an early blastodermal cap stage. The result of

TABLE 3.—*Daily surface plankton hauls at the lower reaches of Cagayan River during the height of the breeding season*

Date	Weather and river condition	Remarks
1939		
February 11	Sunny, no flood, water clear	No eggs and larvae of anga found.
February 12	do	Do.
February 13	do	Do.
February 14	do	Do.
February 15	do	Do.
February 16	do	Do.
		Few dead eggs and larvæ found.
February 17	do	Do.
February 18	do	Do.
February 19	do	Do.
February 20	do	Do.
February 21	do	Do.
February 22	do	Do.
February 23	Rainy, slight flood	Do.
February 24	Sunny, water slightly muddy	Do.
February 25	do	Do.
February 26	do	Do.
February 27	Sunny water clear	Do.
February 28	do	Do.
March 1	Rainy, slight flood	Do.
March 2	Cloudy, water muddy	Do.
March 3	Cloudy and rainy, slight flood	Do.
March 4	do	Do.
March 5	Sunny, but still flooding	Large number of eggs and larvæ found.
March 6	do	Do.
March 7	do	Few were found.
March 8	Sunny, water clear	Do.
March 9	do	Do.
March 10	do	Do.
March 11	do	Do.
March 12	do	Large number of eggs and larvæ found.
March 13	do	Do.
March 14	do	Do.
March 15	do	Do.
March 16	do	Do.
March 17	do	None found.
March 18	do	Do.
March 19	do	Do.
March 20	do	Do.
March 21	do	Do.
March 22	do	Do.
March 23	do	Do.
March 24	do	Large number eggs and larvæ found.
March 25	do	Do.
March 26	do	Do.
March 28	do	Few were found.
March 29	do	Do.
March 30	do	Large number found.
March 31	do	Few were found.

the early cleavage processes is a dome-shaped blastodermal cap made of about 44 visible cells. The blastoderm now covers practically two-thirds of the yolk sphere.

Cleavage continues and at approximately 7 hours after laying, a more or less completed blastodermal cap has been formed. The subsequent cell division results in a large number of very minute blastomeres, so small that the outline of the internal cells cannot be traced. At this stage, the completed blastodermal cap appears as rounded lenticular dome hanging over the surface of the yolk sphere. The edge of the blastoderm seems

to thin out so that in profile the cap forms a gentle curve which appears almost a continuation of the curvature of the yolk sphere. A dark region (by transmitted light) along the edge of the blastodermal cap is the periblast. The formation and differentation of the periblast from the marginal cells of the blastoderm has been fully observed by Aggasiz and Whitman (1885), cited by Kuntz and Radcliffe (1918) and by Budd (1940). This process has also been observed by Kuntz and Radcliffe (1918) in the eggs of *Tautoga onitis.* The special physiological function of the periblastic nuclei in making the yolk easily assimilable by the developing fish embryo has been reported by Wilson (1891) in *Serranus atrarius.* In all probability these embryological changes and processes must have taken place in the eggs of *S. extraneus,* but they were not discernible in the living materials.

"Segmentation cavity" (fig. 8).—Nine hours after laying, the segmentation cavity and the early germ ring become differentiated. The blastodermal cap, preparatory to invagination, gradually changes its shape. The outer surface becomes more convex, covering practically the entire yolk, while the inner surface becomes more concave. This space created between the blastodermal cap and the yolk has been called the "segmentation cavity," and the thickened peripheral zone of the blastoderm, the germ ring. This formation and development of the germ ring has been fully described by Wilson (1891), and cited by Budd (1940).

Embryonic shield (fig. 9).—After the germ ring has been fully formed, the embryonic shield starts to differentiate. This becomes evident approximately 11 hours after laying. It appears as a broad tongue of cells extending forward from the thickened area of the germ ring. This thickened portion is the posterior or embryonic pole. Viewing the blastoderm from above, this triangular mass of cells which is apparently thicker than the adjacent areas marks the early stage in the differentiation of the embryonic shield. By this time, the germ ring has almost entirely covered the yolk sphere.

Primitive streak stage (fig. 10).—Shortly after the embryonic shield has advanced about one-third of the way around the yolk, there occurs a linear thickening along its anteroposterior axis. This is the primitive streak and marks the axis of the future embryo. The further differentiation of the fish embryo begins in the head region and gradually advances posteriorly.

Advanced embryo (*figs. 11, 12, and 13*).—About 13½ hours after laying, the embryo becomes fully formed and the blastoderm has entirely covered the surface of the yolk sphere with the yolk blastophore completely closed. On account of the congestion of the oil globules around the tail region during this stage, Kuffer's vesicle cannot be seen. According to Summer (1900), Kuffer's vesicle is a postanal gut and has an important influence on certain phases of embryonic growth. The free nuclei of the periblast, which are apparently more concentrated about Kuffer's vesicle than elsewhere, no doubt contribute largely to the absorption of the yolk. It is most likely that the concentration of the supply of food about the Kuffer's vesicle is responsible for the rapid growth and development of the tail region.

The fish embryo at this stage becomes highly transparent without any evidence of pigmentation. Even the extraembryonic area is devoid of any sign of pigmentation which is evident in many fishes at this stage. About three somites begin to differentiate and the yolk is gradually reduced in size. At approximately 16 hours after laying, the optic vesicles become evident and about 14 to 16 somites become discernible. The heart, which has attained a fair size, begins to pulsate occasionally. The anteroposterior circulation of the blood is evident. At this stage the fairly developed tail is still attached to the yolk sphere. The oil globules are apparently decreasing in number, being gradually utilized by the rapidly growing embryo. The first sign of muscular movement was observed at this stage.

About 22 hours after laying, constant movement of the embryo was observed. The embryo has now considerably increased in length, so much so that it has almost encircled the much reduced yolk. The auditory capsules become differentiated and the adherent tail becomes completely free from its posterior attachment to the yolk sphere. The embryo remains transparent until this stage without any sign of pigmentation. The vetebral column now becomes discernible, extending from below the auditory capsules to about the tip of the tail.

Hatching.—A few hours before hatching, the movement of the embryo becomes more violent, exhibited by the constant twitching of the body and the swinging of the tail from side to side, as if trying to break out of the egg shell. The twitching and straightening of the embryo possibly results in the rupture of the egg shell and liberation of the young fish. It is well

known that the egg shells of fishes are weakened previous to hatching by enzymic action. This process of hatching takes place from about an hour to three hours under laboratory conditions. In nature, it is presumed that the period of hatching is very much reduced on account of the rolling and aerating action of the river current. As a matter of curiosity, a number of hatching eggs were pricked by a sharp needle and the liberated young were found to be just as healthy and normal as those hatched under natural conditions.

Under laboratory conditions, the eggs were found to hatch between 20 and 50 hours after laying, the eggs having been kept at an almost constant water temperature of 27.5° C. during the period of incubation. The majority, however, of the eggs were found to hatch between 20 and 30 hours after laying.

Larvae (*figs. 14 and 15*).—On account of the weight of large yolk sac of the newly hatched larvae, they fall to the bottom of the culture dishes and remain there for a few hours before they commence to swim toward the surface, and then drop to the bottom by the weight of the body and the unabsorbed yolk. At this delicate stage of the larvae, the tails are still curved as in the shell. The caudal portion of the body gradually straightens out after which they start to swim by using their tails for propulsion. The large head appears to be slightly deflected on account of the fairly large, ovate-elliptical yolk sac. The body appears entirely transparent without any sign of pigmentation. The vent is discernible just a short distance and posterior to the yolk sac. The fully straightened larva measures about 1.1 millimeters long. The fin fold becomes distinctly defined from the middorsal region of the nape toward and around the caudal to the posterior margin of the yolk sac. The optic vesicles and the fin fold remains entirely free from pigments.

A day after hatching (fig. 16) the larva has grown to about 1.5 millimeters long. The large and elongated head is no longer deflected on account of the greatly reduced yolk sac. The eyes are large and prominent. The body across the nape is fairly thick on account of the yolk sac, tapering gently to a long pointed tail. The numerous large somites become very visible from a point just posterior to the primordial pectoral fin to the end of the caudal. The chief characteristic of this stage is the appearance of distinct pigments. Grayish black melanophores become visible across the occiput, on the upper lip, on the anterior and posterior areas of the yolk sac, and about the

the posterior gut region. A series of melanophores one each on the 20 visible somites, extending from the anal opening toward the tail, becomes also evident. Those melanophores across the occiput, upper lip and along the vent produce pseudopodialike extensions, connect one melanophore to another simulating a necklace.

The primordial pectoral becomes visible at this stage. It appears as a protrusion a short distance posterior to the auditory capsules. The fin fold has also widened along the mid-ventral and middorsal regions of the body.

Two days after hatching (fig. 17) the larva has attained a length of about 1.7 millimeters. The thickness of the nape region becomes considerably reduced so that the head region appears now to be quite rounded and the body tapers slightly to the long pointed tail. Below and behind the jaw, the heart can be seen beating regularly in the fairly transparent pericardial cavity between the lower jaw and the comparatively reduced ovoid yolk sac, which still contains a large and a small oil globule.

The general color of the larva at this stage becomes transparent amber, with the prominent iridescent bluish-black eyes. The pupils are jet black. The melanophores on the occiput, and on the upper lip become expanded and a large number of small new ones begin to appear, giving a more or less opaque appearance to the head region. The pectorals become fairly developed.

On account of the transparency of the body, the vertebral column with their ventral and dorsal spines and other internal organs become visible. The fin fold becomes fenestrated, which is an apparent sign of degeneration, while the fin rays of the future caudal fin begins to differentiate. The posterior gut opening (the future anus) has moved farther back. All other features are practically the same as in the first day of the larva.

The larval stages of *S. extraneous* was not carried further than the fourth day stage after hatching, because they started to die after this stage, possibly due to lack of food. They become thin and emaciated after the complete absorption of the yolk on the second day after hatching.

The young larvae hatching from the eggs in the upper streams eventually find their way to the sea, where they grow at a tremendously accelerated rate, due to the enormous amount of food readily available for them. In about a month these larvae attain a length of about 26.5 millimeters, the average

size of the commercial hipon fry; this is a relatively short time and a fast rate of growth, considering the fact that the newly hatched larvae are only about 1.1 millimeters long. Three to four days after their appearance at the river shores, they begin to enter the fresh-water streams, presumably the same streams where they were born. Although this "home stream" phenomenon, which has been conclusively proven in the case of the Pacific salmon and which is now a matter of common knowledge, cannot be demonstrated here in this fish, some indirect evidences seem to justify this assumption.

The occurrence of distinct species of gobies forming the various fry fisheries in different parts of the Philippines, as has been mentioned in the early part of this paper, may lend some support to this claim. It is also probable that most of the larvae of *S. extraneus* do not linger in the sea for more than a month, and in all likelihood, they remain close to the "parent stream". Under these conditions, the location of the identical stream, using some heretofore unknown biological or chemical factors as guide, would not at all be a problem on the part of the anadromous fry. If the salmon, which is known to linger for a few years in the sea and up to several hundred or a thousand miles from the "parent stream" and still return without mistake to the same place, there is very little doubt that *S. extraneus*, with probably as much "intuition" or "intelligence" as the salmon and under a more favorable condition, as enumerated above, could find their way home.

V. DESCRIPTION OF THE GOBY FRY

Two kinds of goby fry enter the fishery; namely, the "hipon" fry which are the young of *Sicyopterus extraneus*, the species under consideration, and the "muli" fry, the young of *Chonophorus ocellaris*. The morphological differences in the two kinds of fry, as well as the difference in their periodic time of appearance, clearly show that they are derived from entirely separate and distinct species. However, there had been some difficulties in determining the species of the young goby fry when they enter the fishery. In order to ascertain the species composing the fishery, the fry were reared in separate glass aquaria in the laboratory until a certain stage when their diagnostic characters were discernible. The comparative length frequencies of these two kinds of fry and the later stage of the hipon fry—the *ankal*—as recorded in Table 4 are graphically shown in fig. 8.

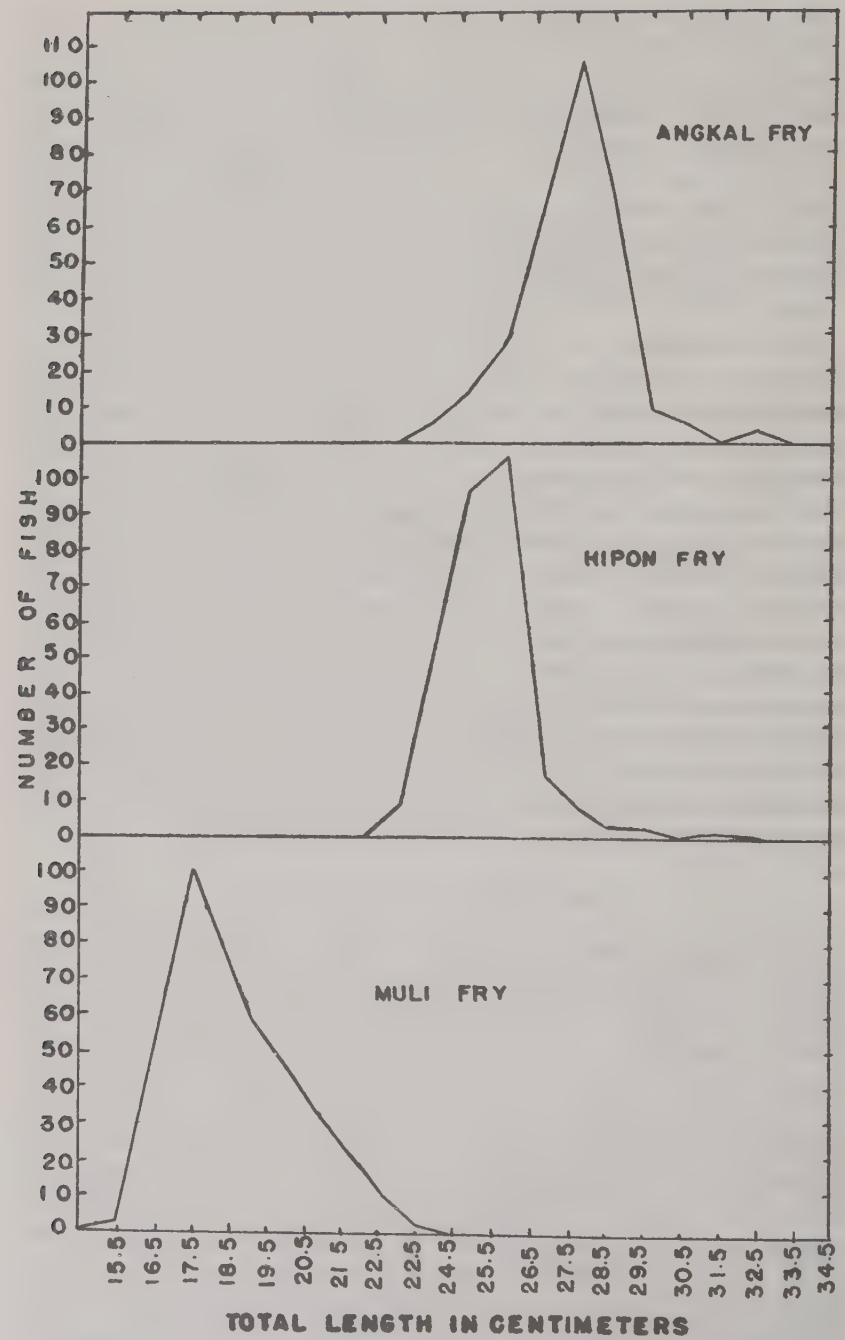


FIG. 8. Total body length frequency polygons of about 300 each of muli, hipon and ankal fry.

Hipon fry (*Plate 2, fig. 4*).—The hipon fry have an average measurement of 25.92 ± 0.74 [7] millimeters total length on the first day of their appearance. They come in innumerable numbers to the shallow river shores, where they appear as a dark-red mass, moving beneath tne surface of the water.

TABLE 4.—*Length frequencies of the three kinds of goby fry.*

Total length	Muli[a]	Hipon[b]	Ankal[c]
mm.	*Number*	*Number*	*Number*
15.1–16.0	3		
16.1–17.0	41		
17.1–18.0	101		
18.1–19.0	57		
19.1–20.0	44		
20.1–21.0	24		
21.1–22.0	10	9	
22.1–23.0	2	58	
23.1–24.0		115	6
24.1–25.0		96	14
25.1–26.0		06	30
26.1–27.0		8	58
27.1–28.0		3	107
28.1–29.0		3	69
29.1–30.0		1	8
30.1–31.0			
31.1–32.0		1	6
32.1–33.0			0
33.1–34.0			2
34.1–35.0			
Total	300	300	300

[a] Collected February 18, 1940, Cagayan River, Oriental Misamis Province.
[b] Collected February 2, 1940, Barrio Macabalan, Cagayan, Oriental Misamis Province.
[c] Collected February 5, 1940, Cagayan Province, Oriental Misamis Province.

Here and there one may notice "flips" on the surface of the water when some predatory fish surge into the school of fry. It is during this stage that the fishermen watch for them with much interest, and when they are spotted every fishing outfit in the community sets out to catch them. All these signs of activity indicate that the goby fry season has commenced.

In life, an individual fry appears transparent amber, with only the jet black eyes prominent. About six to seven transverse V-shaped lateral bands are discernible, extending from above the base of the pectoral to the base of the caudal fins. These bands become indistinct ventrally, especially those towards the head region. The elongated and more or less rounded body appears to be deeper below the first dorsal and tapers gradually posteriorly. There are two fairly distinct gray blotches on the vertex; both lips are covered with dark grey melanophores, these being more prominent on the upper lip; the base of the pectoral is spotted with distinct dark melano-

[7] Standard error.

phores. There are about 20 to 22 series of dark gray melanophores, extending from the base of the anal fin to the base of the caudal peduncle, those along the anal being paired on each side of the belly and becoming single posteriorly. The caudal base is lined with a few dark melanophores, with those on the upper and lower angles of the hypural region being more prominent.

To the naked eye, the body of the fry appears to be entirely scaleless, but closer examination under a compound dissecting microscope reveals the presence of distinctly ctenoid scales. The head, nape, and pectoral regions are naked, and distinct scalation becomes evident from a point just below the posterior margin of the first dorsal fin where the rows of scales converge. Posterior to this point the entire body is definitely scaled.

All the fins at this stage are fairly well developed and are distinctly hyaline. The fin rays, however, have not started to branch, except those of the caudal. The sucking ventral fin is spatulate.

Ankal fry (*Plate 2, fig. 5*).—The *ankal* fry are the advanced stage of the hipon fry and are about a week older. This is evidently the stage of the fry that starts the fresh-water life of the fish. At this time they measure, on the average, about 28.31 ± 0.08 millimeters in total length. When they enter fresh water their flavor changes. In some species, according to Herre (1927), they become actually bitter.

On entering fresh water there is a notable change in the mode of life of the fry from the free-swimming stage, characteristic of the hipon fry, to the creeping and demersal stage of the ankal. Because of this change in the mode of life of the ankal fry, the goby fry fishermen seldom catch them with their fine-meshed beached seines. They hold fast with their sucking ventral fins to the sand and mud on the fishing ground.

The ankal fry are easily distinguished from the hipon fry by their darker color; their tougher, more compact and longer body; and their comparatively distinct scales, which are easily visible even with the naked eye. The dark color of the ankal fry is brought about by the increased dispersion and thickness of the dark gray bands of chromatophores. About seven or eight of these transverse bands are clearly evident both in fresh and preserved specimens, with those toward the posterior half of the body, especially the last five, being more distinct. In some specimens, these bands become distinctly V-shaped, widening dorsally and tapering ventrally, while in others they

are constricted medially. Anteriorly, the third and fourth bands may or may not become fused along their latero-medial line. However, the seventh and eighth bands on the caudal peduncle are often fused, thereby forming an anchor-shaped band on the caudal base.

Muli fry (*Plate 2, fig. 3*).—These fry, which are derived from another distinct species of goby, *Chonophorus ocellaris*, are easily distinguished from the hipon and ankal fry of *Sicyopterus extraneus* by the comparatively small size and slenderness of the former. The muli fry measure on the average about 18.5 ± 0.021 millimeters long (total length). Although they form an insignificant portion of the goby fry catch in Cagayan River, they are, however, considered delicacies, especially in the preparation of special kinds of fish sauerkraut, because they are much finer, more tender, and with better flavor than the other goby fry. On the first day of their appearance in the sea, an individual fry appears translucent whitish-amber, with only the large jet black eyes prominent. The body is elongated and rounded, becoming slightly flattened toward the caudal fin. It is practically devoid of any distinct cross bands, save for a fairly distinct dark spot just above the last fin ray of the anal fin. A large, dark melanophore is evident at the upper angle of the caudal base. In life, two yellowish-orange chromatophores are visible at the upper and lower angles of the caudal base, but these disappear after the fry have been fixed in 3 per cent formaldehyde or in 70 per cent alcohol. There is a series of about 10 to 12 fairly large paired melanophores on each side of the pelvic region. In some specimens this series of melanophores is continued to the base of the anterior margin of the anal fin. There is also a series of smaller melanophores, about 10 pairs, along the base of the anal fin; these are contained on each side of the belly to the last anal fin ray, where they form a single series to the caudal base.

In advanced stages of the muli fry, commonly called *ankal sa muli*, which is equivalent to the migrating stage (*ankal*) of the hipon fry, the fry become fairly distinctly barred. About 5 to 6 dark-gray, narrow transverse bands become evident when the fry start their anadromous life. In general appearance, like the ankal fry, the body becomes darker, tougher, and more compact than its early stage.

All the fins of the young muli fry are hyaline and devoid of any markings, and none of the fin rays have yet started to branch. With the exception of the anterior half, the body

is covered with quite indistinct and fine ctenoid scales. These are so minute that they can be seen only under the high magnification of a compound dissecting microscope.

In the muli fry there is no apparent change of mode of life from the purely swimming stage to the creeping stage, as has been observed in the hipon fry. It was observed that the muli fry continue their pelagic swimming habit from their first appearance until they are far upstream, when they live like the adults of *S. extraneus* under rocks and boulders in swiftly flowing portio .s of the stream. The migrating fry may be observed to be moving in patches or groups of 10 to several hundred or more, braving the river current, preferably taking the back eddies along the banks of the river in their upstream migration.

VI. PERIODIC APPEARANCE AND DURATION OF GOBY FRY RUNS IN CAGAYAN RIVER

To determine the periodic appearance and duration of the goby fry runs in Cagayan River, which is equivalent to the fishing period, actual observations and examinations of the specimens were made from time to time during the entire period of investigation. These observations were corroborated by the records of catch and the verbal information of experienced fishermen. The results of this study are recorded in Table 5 and graphically shown in figs. 9 and 10. Fig. 9 shows, for each month, the duration in days of the hipon and muli fry runs in Cagayan River, and fig. 10, the monthly lunar fishing periods of goby fry for 1938 and 1939. The time of the first catches of the hipon fry fishermen has been taken as the date of first appearance, and the end of the run has been taken as either the time the runs cease along the river shores or the time the fry enter the river in their upward migration.

Hipon fry.—The date of first appearance of the first batch of the monthly run of hipon fry varies from one to nine days, usually between the second and fifth day after the full moon, or shortly after the highest tide of the series. They may appear early or late, depending probably upon certain environmental factors. An early appearance of the first and subsequent batches during the lunar month occurs when there had been heavy rain and freshets a month earlier. This condition is usually followed by a good run of fry. Such is the general belief of the fishermen. Although this apparent association between freshets and the amount and time of first appearance

TABLE 5.—*First appearance and duration of goby fry runs in Cagayan, Oriental Misamis Province (1937–1940).*

Goby	1937*	1938	1939	1940	Average	Remarks
	Days	*Days*	*Days*	*Days*	*Days*	
January						
Hipon	8–13	24–27	12–17	30–31	5.70	
Muli	17–18	6–7	26–27	15–16	2.00	
February						
Hipon	3–8	20–26	10–17	1–5	6.75	Principal fishing season (panuig).
Muli	15–17	6–7	23–24	18–19	2.00	
March						
Hipon	2–7	21–25	7–17	1–3	5–85	
Muli	17–18	6–7	22–23	14–15	2.00	
April						
Hipon	7–8	25–26	14–15	2–3	2.00	
Muli	-------	-------	22–23	14–15	2.00	
May						
Hipon	9–10	25–27	15–16	1–2	2.00	
Muli	-------	6–7	23	-------	1.50	
June						
Hipon	6–7	22–24	12–13	-------	2.30	
Muli	-------	-------	23	-------	1.00	
July						
Hipon	8	23–24	12	29–30	1.50	
Muli	-------	-------	-------	-------	-------	Monthly fishing season (bulan-bulan).
August						
Hipon	-------	22–23	12–13	-------	2.00	
Muli	-------	7–8	-------	-------	2.00	
September						
Hipon	2–3	20–21	12–13	-------	2.00	
Muli	-------	-------	21–22	-------	2.00	
October						
Hipon	-------	20	12–13	-------	1.50	
Muli	-------	-------	-------	-------	-------	
November	**					
Hipon	-------	21–22	9–10	-------	2.00	
Muli	-------	-------	-------	-------	-------	
December	**					
Hipon	-------	20–21	9–10	-------	2.00	
Muli	-------	-------	20–21	-------	2.00	

* No record of appearance
** No observation made

of the runs a month later was not verified in this present investigation, it appears to be plausible. Since the hatching eggs and larvae are carried down to the sea by the river current, the occurrence of rain and consequent freshets would wash down more of them than during the normal condition of the river. In view of this situation, the run of goby fry a month later would be increased.

It will be seen in fig. 10 that the hipon fry appear with almost periodic regularity in every lunar period, or approximately at four week intervals. The significance of this is that their periodic appearance seems to be directly associated with the tides. The runs of hipon fry were observed to be most abundant during or shortly after the highest tide of the series. The only decided advantage accruing to the fry by following the movement of the tide seems quite evident. The high series of tides flood up the river mouths and even as far as 2 to 3 miles upstream. These conditions afford the migrat-

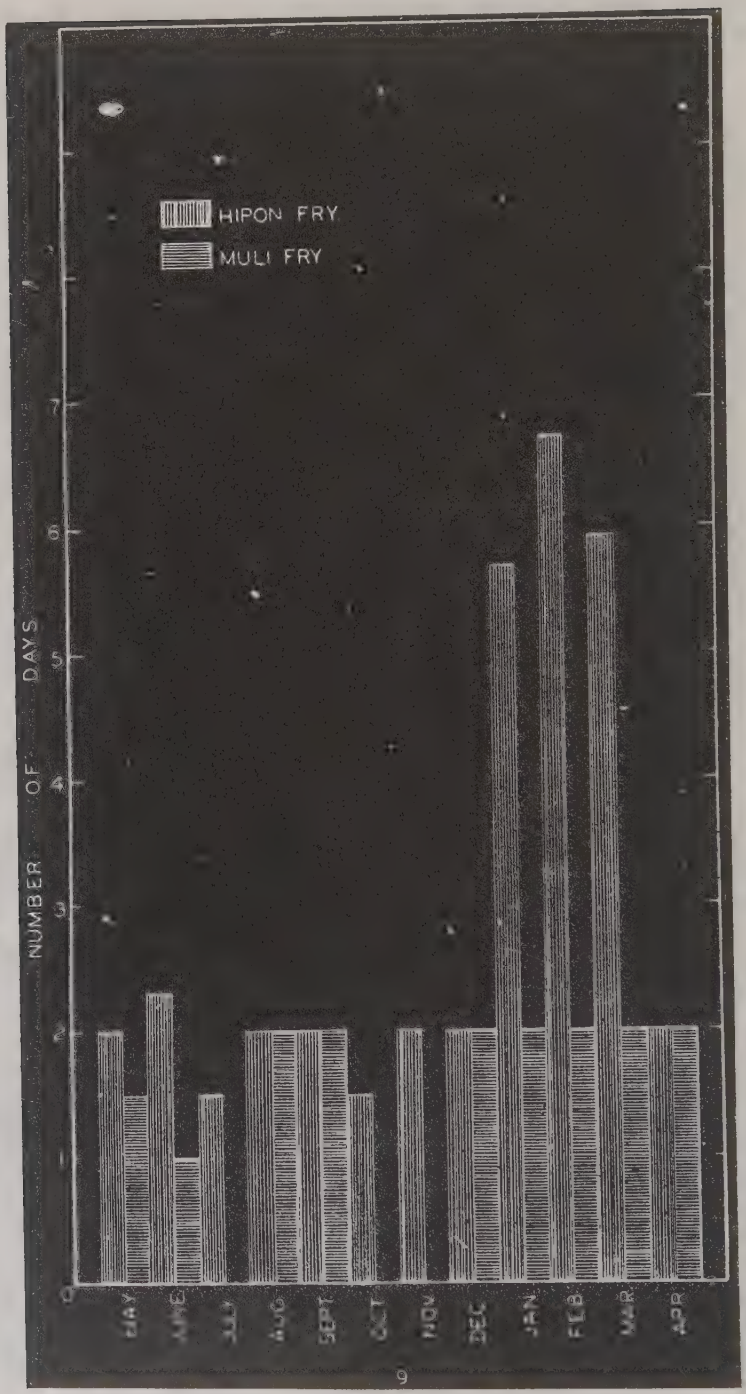


FIG. 9. Average monthly duration in days of hipon and muli fry runs in Cagayan River, Oriental Misamis Province.

ing fry an easier start and a more favorable situation than those existing during the periods when the tides are low and there are no favoring currents for the migrating fish.

In the hipon fry fisheries of the other important rivers of northern Mindanao, such as in Surigao River, Surigao Province; Agusan River, Agusan Province; Tagaloan River, Oriental Misamis Province; and Mandulog River, Lanao Province, a similar association between the tides and hipon runs occurs, as gleaned from the reports of goby fry fishermen in these places. In an earlier report (Manacop, 1940), it was noticed that the appearance of the hipon runs in these places, including those in Cagayan River, often occur simultaneously, sometimes varying only a day or two. In northern and northwestern Luzon, this periodic appearance of the hipon fry was likewise reported by Taylor (1919) in the *ipon* fisheries of Abra River; Montilla (1931), Herre (1927), Blanco (1938), and, Villadolid and Blanco (1939), in similar fisheries of Cagayan River, Cagayan Province, and of the Ilocos Regions. However, the date of the first appearance of the run appears to vary in different places. The ipon fry of the northern and northwestern parts of Luzon usually appear with the incoming tides about nine days after the full moon, being most abundant about three days after the full moon when the tides are highest. Any slight variation in the date of the first appearance of the hipon runs in different parts of the Philippines may be accounted for by the following factors: (1) the time of high and low water varies in different parts of the Philippines on account of the varied effects of the currents in the Pacific Ocean and the China sea; (2) the fisheries are derived from entirely diffrent species and even genera; and, (3) the environmental conditions vary in these places.

With regard to the duration of the hipon runs in Cagayan River, Oriental Misamis Province, it was found to vary from 5 to 7 days during the principal fishing months, and from $1\frac{1}{2}$ to 2 days during the "monthly" fishing seasons (fig. 9). The duration of the hipon runs appears to be prolonged during the principal fishing months due to the fact that two to three batches of hipon fry appear successfully during this period, while during the other months of the year only one batch of fry usually occurs. A batch of hipon fry (*tugnos*) usually

runs from two to four days after its first appearance in the sea before it begins to ascend the fresh-water streams. Shortly after the cessation of the run of the first batch, the second batch appears, and then the third, if there is any.

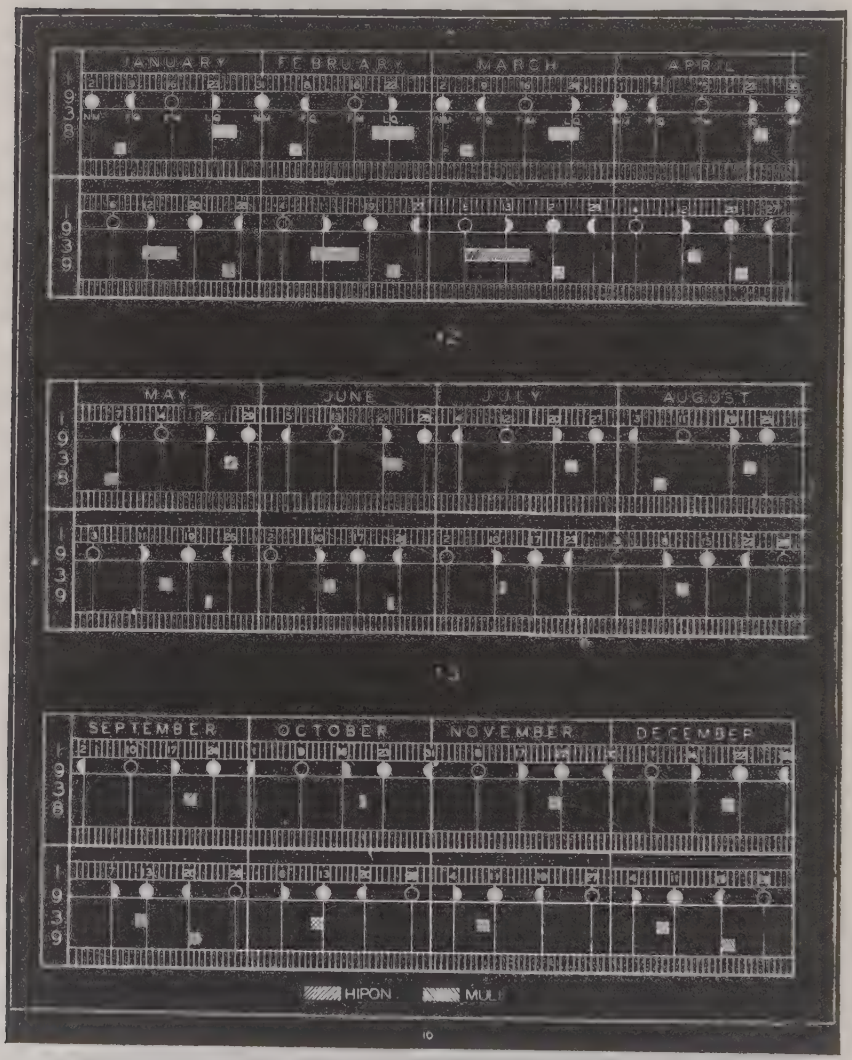


Fig. 10. Monthly lunar periods (1938–1939) and duration of hipon and muli fry runs in Cagayan River, Oriental Misamis Province.

As to the relative size of each batch, no definite comparative study has been made. However, the concensus of hipon fish-

ermen is that it is either the first or second batch that yields the biggest haul.

In northern Luzon, according to Villadolid and Blanco (1939), the duration of the monthly runs during the six months fishing period (September through as late as March) is about 15 days for every month. Although no mention has been made by the foregoing authors regarding the number of batches of goby fry occurring in each monthly run, it is probable that not less than two batches successively appear every month.

The nonappearance of the hipon fry run during certain lunar periods may be ascribed to certain factors, such as: (1) failure in spawning or excessive mortality rate of the eggs or young fish, as mentioned in the early part of this discussion; or; (2) the run was so insignificant that it was not observed in the catch of the hipon fishermen.

Muli fry.—The muli fry runs usually appear on the third day after the new moon, or approximately after the second series of high tides of the month. The run usually extends from one to two days, seldom three, on account of the fact that only one batch of fry has been observed to occur in each monthly run. This run appears to be periodic although quite erratic throughout the year. As in the case of the hipon fry runs, the occurrence of a break in the periodicity of appearance of the muli fry may be accounted for as due to spawning failure or some spawning recess (resting period) of the fish. These statements can only be considered tentative because the life history and habits of the muli (*Chonophorus ocellaris*) have not been sufficiently studied to warrant definite conclusions.

The periodic appearance of the hipon fry runs in Cagayan seems to be conclusive evidence that *S. extraneus* and probably *Chonophorus ocellaris* spawn periodically. If spawning were not periodic, this regular appearance of these one-month-old goby fry every lunar period would not occur.

In view of this apparently close association between the periodic appearance of the runs of goby fry and lunar period, it is not surprising that the fishermen can forecast with fair accuracy the probable date of the first appearance of the two kinds of goby fry on the river shores, using the phase of the moon as their only guide. A few days before the expected appearance of the fish, necessary preparations of all fishing outfits will be observed all along the fishing communities not

only in Cagayan, Oriental Misamis Province, but also in many other parts of the Philippines where the fishery occurs.

VII. NOTES ON THE FOOD AND FEEDING HABITS

The food and feeding habits of both the adults and the fry were observed in the field and in the laboratory. Observations in the field and the rearing of both stages of the fish in glass aquaria in the laboratory were undertaken. For the determination of the food, examinations of the stomach contents of the adults were made. Table 6 shows the results of this study of about 20 filled stomachs of anga, collected on June 14, 1940, from Cagayan River. On account of the extreme minuteness of the food organisms, it was difficult to determine the proportion of the food organisms contained in each stomach. Therefore, relative degrees of occurrence of the food organisms, indicated by plenty (P), common (C), few (F), and rare (R), were used. The species of the different food organisms could not be determined because of their macerated and digested conditions.

TABLE 6.—*Examination of the stomach contents of adult anga, collected June 14, 1940 in upper Cagayan River*

Number of fish	Diatoms	Lyngbya	Calothrix	Spirogyra	Stigeoclonium	Penium	Sygnema	Oedogonium	Cosmarium	Organic matter
1	[1]P	P	P	[2]C	C	[3]R	R	R	[4]F	P
2	P	P	P	C	C			F	F	P
3	P	P	R		F			R	F	C
4	P	C	P	F	F	R		C	R	P
5	P	C	P	C	F			R	R	C
6	P	C	C	F		R	R	C		P
7	P	C	C	F		R	C			C
8	P	C	C		C		P			P
9	P	C	R	F	F		R	R	R	P
10	P	C	P	F	F	R	R		R	P
11	C	C	P		F	R	R		F	P
12	P	C	P						R	C
13	P	C	C	C	C	R	F	F		P
14	P	C	C							P
15	P	C	C		C	R	F		R	C
16	P	C	C	F	C	R	F	F	F	C
17	P	C	C		C	F	F	C	R	P
18	P	C	C	C				C		P
19	P	C	C		C	F				P
20	P	C	C	C	F				R	P

[1] Plenty (P). [2] Common (C). [3] Few (F). [4] Rare (R).

The adults were found to feed principally on various kinds of algae, the pennate diatoms predominating. *Lyngbya, Stegioclonium, Calothrix*, and *Spirogyra* were the common food organisms found in the stomach contents of the adults, and

Penium, Sygnema, Oedogonium and *Cosmarium* the rare forms. The greatest bulk of the stomach contents, however, consisted of an unidentifiable mass of organic matter. The ankal fry that were reared for some time in the laboratory were observed to feed voraciously and live on those kinds of algae which were collected from Cagayan River.

In the field, the adults and the migrating fry in the upper streams were observed to be feeding on the accumulated, thin layer of organic matter on the surface of stones under water. Upon closer examination of this organic matter, it was found to consist chiefly of various species of diatoms, with some scattered colonies of green, and blue-green algae.

Both the adults and the migrating fry (*ankal*) have a very interesting mode of feeding. The ventral mouth, characteristic of bottom feeders, suggests that the peculiar mode of feeding similar to the mechanical action of a lawn mower or scraper. The hardened, wide, dentate-crenate lips perform this mowing or scraping action. Using the sucking ventral fin for clinging firmly to rocks, the busy mouth scrapes off the diatom accumulation on the stones. After going over one stone, the fish move to another and begin feeding again. The area fed upon by the fish presents a characteristic cleared patch, like a newly mowed grass lawn or scraped path. During this mode of feeding, every now and then particles of sand accidentally get into the mouth, and when this occurs the foreign body is immediately ejected with an apparently spitting action of the tongue and lips. The canine teeth and lips probably keep the food particles from falling off.

The change in the mode of life of the hipon fry, as mentioned in the early part of the paper, is probably brought about by the change in the range of feeding habits. There has been observed a notable change in the position of the mouth of the goby fry from terminal, characteristics of the hipon fry stage which are surface or top feeders, to inferior, characteristic of the ankal or migrating stage which are bottom feeders. A parallel phenomenon has been reported by Steward (1925) in his study of the development, growth, and food habits of the white sucker, *Catostomus commersonii* Lesueur.

Annandale and Hora (1925) described this interesting mode of feeding as well as the food of a related species, *Sicyopterus*

garra, in streams of the Andaman Islands. Quoting the authors:

> . . . They cling to rocks in rapidly-running water by means of a ventral sucker, and feed by scraping organic matter, mainly minute algæ, from the surface of rocks to which they adhere. Rocky beds of stream is covered by a thin film of deposit and this is cleared away by *Sicyopterus* by its fringed lips and then clinging by its ventral fins (cup-like suckers), it scrapes off algæ with a pair of horny pads on its lower jaw, assisted probably by its strong canine teeth. Upper lip pendant and fringed to prevent the falling of food particles.

This unique and interesting mode of feeding of *Sicyopterus* with the characteristic structure of the mouth has actually to be observed in order to appreciate the peculiar mechanical operation of the lips.

SUMMARY

1. The goby fry fisheries occur in many places in the Philippines, but they are commercially exploited chiefly in the northern and northwestern parts of Luzon, and in the northern and southeastern parts of Mindanao. As a whole, the total estimated value of the product of this fishery may be placed at no less than 500,000 pesos annually, with Cagayan River, Oriental Misamis Province, ranking as one of the principal producing centers in the southern part of the Island.

2. The principal species entering the goby fry fishery in Cagayan River are *Sicyopterus extraneus* Herre (anga) and *Chonophorus ocellaris* (Broussonet), *muli,* with the former making the major part of the commercial catch of hipon fry and the latter the minor element of muli fry.

3. The fishing season may be classified into two periods; namely, "yearly" (*panuig*) or principal, and the "monthly" (*bulan-bulan*), The principal fishing season extends from January to March, the period concurring closely with the spawning season of the fish. The rest of the year, which has a very insignificant amount of hipon fry catch, covers the "monthly" season.

4. The globy fry are chiefly caught by beach seines (*baling*), scissors nets (*sarap*), fish barricades (*golgol sa hipon*), and other similar gears which are considered to be of minor importance, their catch being intended principally for the fresh-fish markets, while those of the baling are for the preparation of the commercial salted fish paste (bagoong). The adults are commonly taken by a number of forms of gear, such as the cast net

(*taclob*), fish barricade (*golgol sa anga*), and spear gun (*pusil-pusil*).

5. All the materials used in this study were collected mostly from Cagayan River, Oriental Misamis Province, unless otherwise stated.

6. A detailed study of the life history and habits of *Sicyopterus extraneus* Herre, has been dealt with in this investigation, and the results are summarized as follows:

a. S. extraneus (*añga*) spawns throughout the year, with the principal spawning months extending from December to February.

b. Each fish probably spawns more than once during the season, with every fish either actively spawning or developing mature eggs at all times during the year.

c. Indirect evidence seems to indicate that the anga spawns with regular periodicity, at approximately every full moon.

d. A distinct sexual dimorphism has been found in the anga, the male being longer than the female on the average, and having the first dorsal fin spines much more prolonged than in the females'. Males measure 6.82 ± 0.023 centimeters and the females 6.3 ± 0.021 centimeters long.

e. The eggs are demersal and are laid on the under surface of stones in moderately flowing portions of the river. They are held together to the substrate by numerous tufts of gelatinuous threads.

f. The eggs hatch in a day or two. In the upper reaches of the river where they are laid, and when they are about to be hatched or fully hatched, they are carried down stream by the river current to the sea. After a month or so, they reappear on the river shores as the commercial form of goby fry (*hipon, or muli*).

6. The goby fry that enter the commercial haul are estimated to be about a month old.

7. The runs of these goby fry were observed to appear with almost regular periodicity, the hipon fry usually between the second and fifth day after the full moon of every month, and the muli fry about the third day after the new moon.

8. These periodic runs are apparently associated with the movement of the tides, with the hipon fry appearing during or shortly after the highest tide of the series, and the muli fry during the second highest tide of the series of the same lunar period.

9. The hipon fry runs appear to be much prolonged during the principal fishing months, being from about 5 days to 7 days, as compared with the rest of the year when the usual duration is about 2 days.

10. Each "batch" (*tugnos*) or hipon fry run usually lasts from 2 to 4 days, sometimes 5, along the river shores.

11. The duration of the runs, which is equivalent to the lunar fishing period, depends primarily upon the number of batches of goby fry occurring in every monthly run.

12. Two to three batches of goby fry occur during the runs of the principal fishing months while only a single batch appears each month throughout the rest of the year.

13. The monthly lunar run of muli fry does not last more than two days, usually one day because there often occurs only one batch in each monthly run.

14. Indirect evidence seems to show that, like the Pacific salmon, the goby fry return to the same "parent stream" where they were born.

15. Breaks in the regular periodicity of the runs of either the hipon or muli fry may be ascribed to the following factors: (*a*) the occurrence of some spawning failure brought about by unfavorable conditions; (*b*) the insignificance of the run to be noted, and/or actual cessation of spawning activity (resting period).

16. The adults and migrating fry have a peculiar and interesting mode of feeding, simulating the mechanical action of a lawn mower or scraper. The fish are purely vegetarian, feeding mostly on diatoms, some blue-green algae (*Lyngbya* and *Calothrix*) and a host of green-algae (*Spirogyra*, *Stigeoclonium*, *Oedogonium*, *Sygnema*, *Penium*, and *Cosmarium*,) each arranged in the order of its relative degree of occurence in the stomach contents of the fish.

17. With the present knowledge of the life history and the breeding grounds of anga, the mooted question as to where the fish spawn has been definitely settled—they spawn in fresh water and are not catadromous as has been previously claimed.

RECOMMENDATIONS

For further study and regulation of the fishery, the following points are recommended:

1. A complete record of the monthly and annual catch of both the hipon and muli fry is urgently needed for statistical

analysis in order to determine the present condition of the fishery.

2. For the proper conservation of the goby fry fishery in Cagayan River, Oriental Misamis Province, a closed season in the catching of the adults, consisting of *Sicyopterus extraneus* and *Chonophorus ocellaris* extending from December 1 through March 15, of each year, is recommended. To regulate the catching of the fry, a law should be promulgated prohibiting the catching of the migrating fry (*ankal* of both muli and *hipon*) in the river. This plan, which was tried during the period of investigation of the fishery at Cagayan River, has apparently resulted in a remarkable rehabilitation of the gradually declining fishery.

3. Further studies are needed on the proper preservation and preparation of a better quality of salted fish paste so that it will have a general local appeal, and at the same time serve as export to foreign markets.

4. Similar biological studies of the other goby fry fisheries of the Philippines, especially those of northern Luzon, should be undertaken in order to conserve this commercially important natural wealth.

5. The findings of probably annular markings, or breeding "checks", on the scales of anga should lead to further investigation in order to determine the definite ages of the fish at different size groups.

BIBLIOGRAPHY

ANNANDALE, N., and S. L. HORA.

1925. The fresh-water fish from the Andaman Islands. Records Indian Museum, Calcutta, 27 Part II: 33–41, 2 pls.

BLANCO, GUILLERMO J.

1938. The fisheries of northeastern Luzon and the Babuyan and Batanes Islands. Phil. Jour. Sci. 66; 501–521.

BUDD, PAUL L.

1940. Development of the eggs and early larvae of six California fishes. California Division of Fish and Game, Fish Bulletin, No. 41: 53, 66 figs.

CLARK, FRANCES N.

1925. The life-history of *Leuresthes tenius*, an atherine fish with tide controlled spawning habits. California Division of Fish and Game, Fish Bulletin, No. 10: 49, 6 pls.

CURTIS, BRIAN.

1938. The life story of the fish. 1st edition, vii + 260. D. Appleton-Century Company Inc., New York and London.

DERANIYAGALA, P.E.P.

1937. Two catadromous fishes new to Ceylon. Spolia Zeylonica, Colombo (B) 20: 181–184, 4 pls.

EVERMAN, BARTON WARREN.
1853. Investigation of the aquatic resources and fisheries of Porto Rico by the United States Fish Commission steamer Fish Hawk in 1899 (Extract from Fish Comm. Bulletin for 1900), 350 p., 52 pls.

HERRE, ALBERT W.
1927. Gobies of the Philippine and the China Sea. Manila. Bureau of Science Monograph, No. 23: 352, 30 pls.

HILDEBRAND, SAMUEL F.
1922. Notes on habits and development of eggs and larvae of silversides, *Menidia menidia* and *Menidia beryllina*. Bull. U. S. Bureau of Fisheries 38 (1921–1922) 113–120.

KUNTZ, ALBERT, and LEWIS RADCLIFFE.
1918. Notes on the embryology and larval development of twelve teleostean fishes. U. S. Bureau of Fisheries, Bulletin 35: 87–134, 126 figs.

MANACOP, PORFIRIO R.
1936. A new phallostethid fish with notes on its development. Phil. Jour. Sci. 59: 375–381, 2 pls.

MANACOP, PORFIRIO R.
1940. The hipon fishery of northern Mindanao (manuscript) 1948.

MANE, ANDRES M.
1929. A preliminary study of the life history and habits of kanduli (*Arius* spp.) in Laguna de Bay. The Philippine Agriculturist 18: 117, 2 pls.

MANE, ANDRES M.
1934. Spawning and feeding habits of ayungin, *Mesoprites* plumbea (Kner), a common theraponid fish in Laguna de Bay. Philippine Agriculturist 23 no. 6: 502–515, 3 figs.

MONTILLA, JOSE.
1931. The ipon fisheries of northern Luzon. Phil. Jour. Sci. 45 61–75, 6 pls.

RICH, WILLIS H.
1920. Early life history and seaward migration of chinook salmon in Columbia and Sacramento Rivers. Bull. U. S. Bureau of Fisheries 37: (1919–1920) Document No. 887, 73 p.

SIMPSON, GAYLORD GEORGE, ANNE ROE.
1939. Quantitative zoology. 1st edition, vii + 414 p., 62 figs. McGraw-Hill Book Company Inc. New York and London.

STEWART, NORMAN HAMILTON.
1926. Development, growth and food habits of the white sucker, *Catostomus commersonii* Lesueur. U. S. Bureau of Fisheries Document No. 1007 42: 147–183.

SUMMER, F. B.
1936. Kuffer's vesicle and its relation to gastrulation and concresence. New York Academy of Sciences, Memoirs 2 No. 2: 47–84, 34 figs.

TALAVERA, FLORENCIO, HERACLIO R. MONTALBAN.
1332. Fishing appliances of Panay, Negros and Cebu. Phil. Jour. Sci. 48: 429–483, 15 pls.

TAYLOR, EDWARD H.
1919. Ipon fisheries of Abra River. Phil. Jour. Sci. 14: 127–130.
THOMPSON, WILLIAM F.
1919a. The spawning of the grunion. California Division of Fish and Game 5: 201.
1919b. The spawning of the grunion (*Leuresthes tenius*). California Fish and Game Commission, Fish Bulletin No. 3: 1–29.
VILLADOLID, DEOGRACIAS V., and GUILLERMO BLANCO.
1939. Fish-fry fisheries of the Philippines. Phil. Jour. Sci. 69: 69–100.
VILLADOLID, DEOGRACIAS V., and PORFIRIO R. MANACOP.
1934. The Philippine Phallostethidae, a description of a new species and a report on the biology of *Gulaphalus mirabilis* Herre, Phil. Jour. Sci. 55: 193–220, 5 pls. 3 text figs.
WALFORD, LIONEL A.
1932. The California Baracuda (*Sphyraena argentea*). California Division of Fish and Game, Bulletin No. 37: 122, 6 pls., 32 figs.
WILSON, H. V. P.
1891. The embryology of the sea bass (*Serranus atrarius*). U. S. Fish Commission. Bulletin 9 (1889) 209–277, 20 pls., 12 figs.

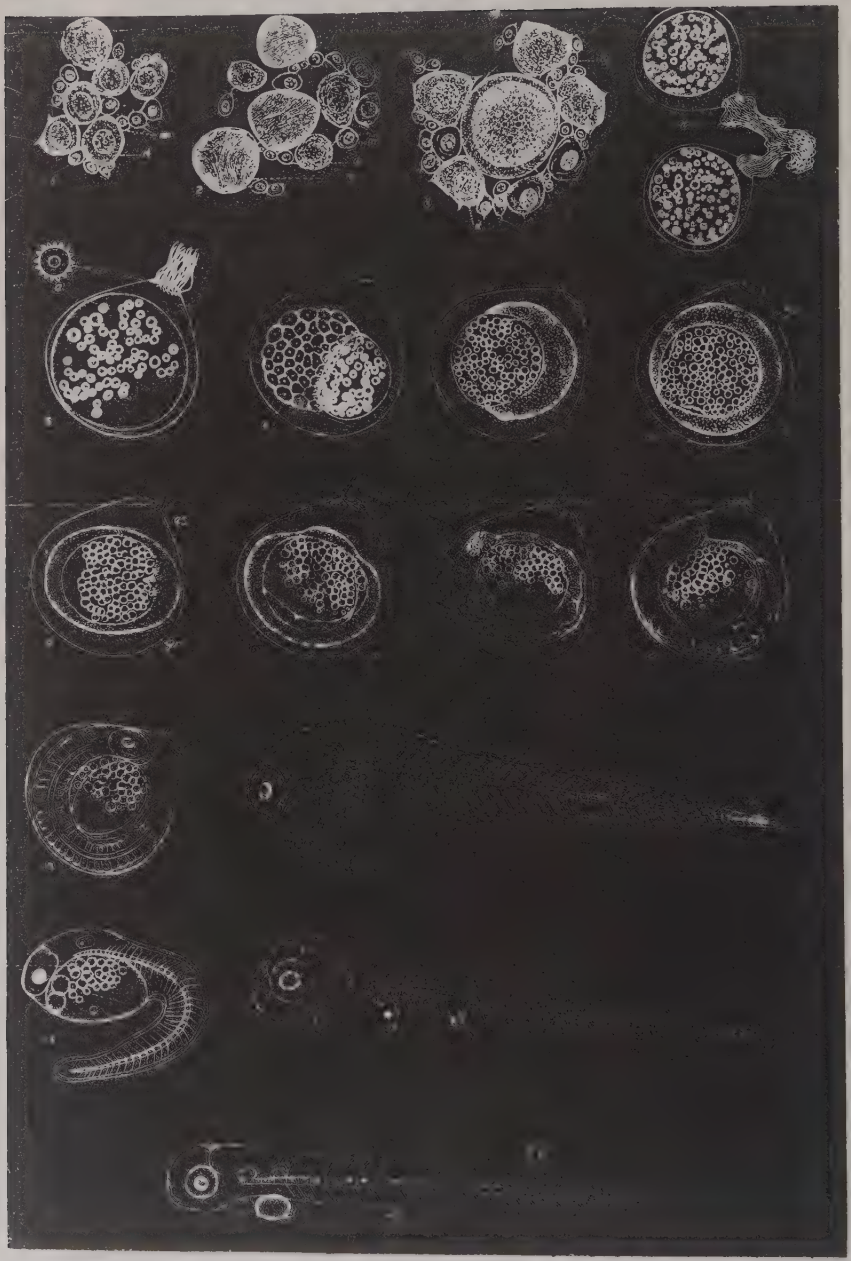


PLATE 1.

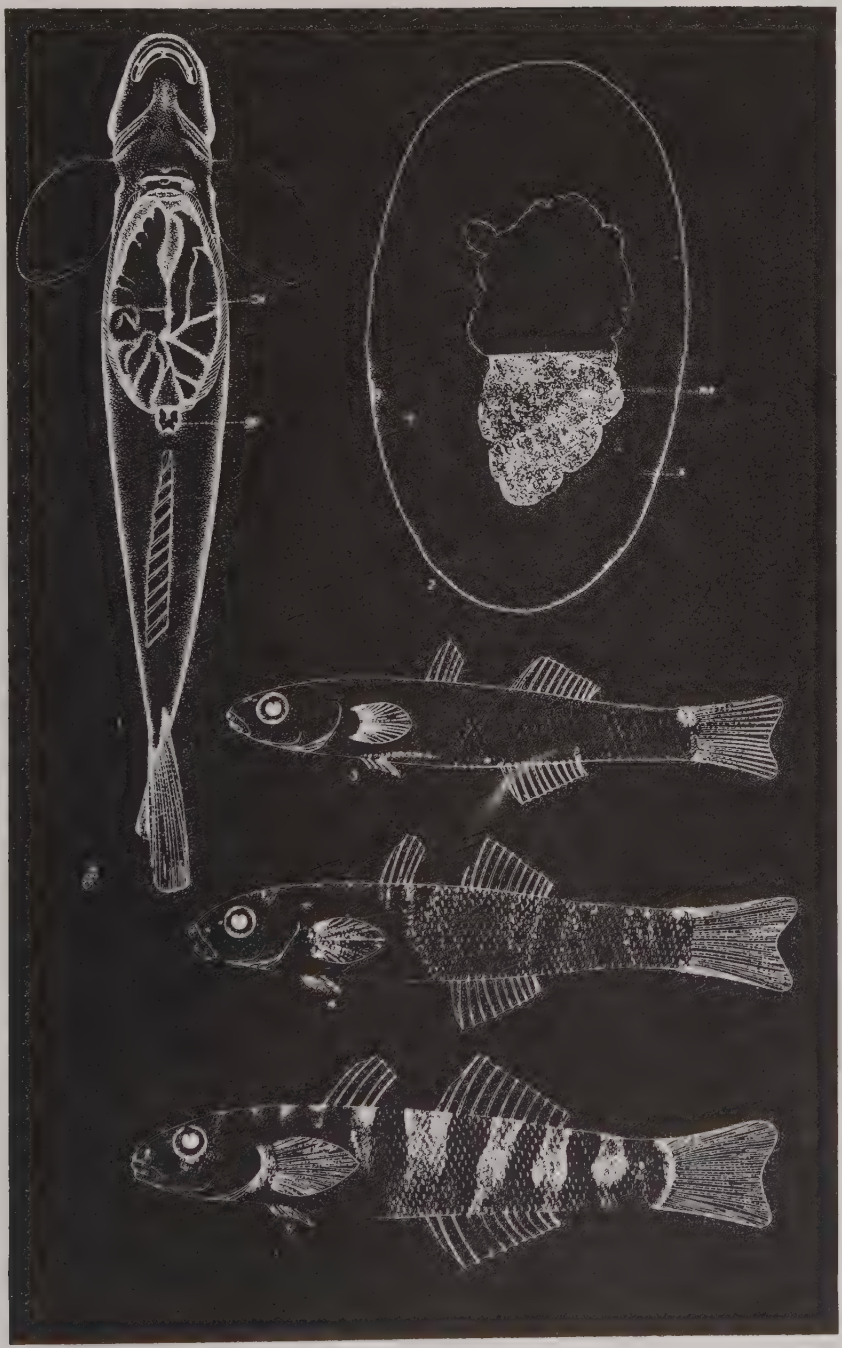
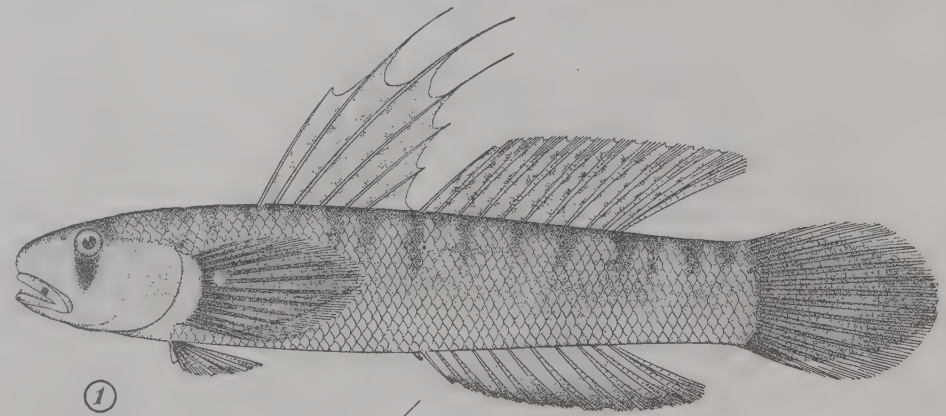
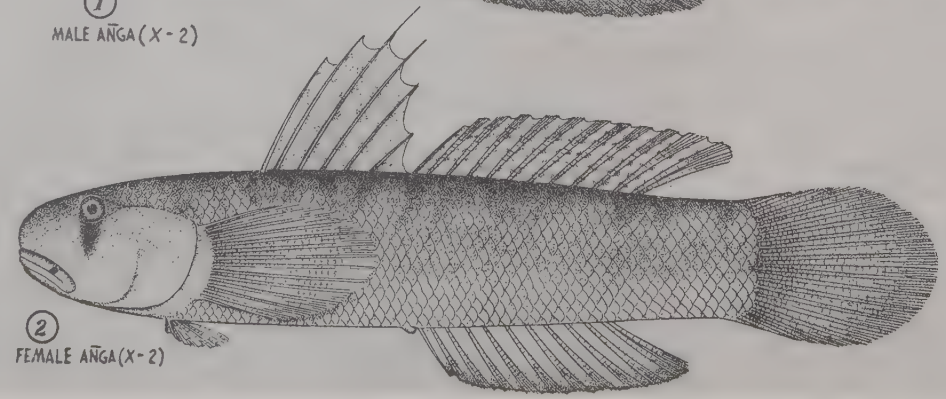


PLATE 2.



1 MALE AÑGA (X-2)



2 FEMALE AÑGA (X-2)

PLATE 3.

ILLUSTRATIONS

PLATE 1

FIG. 1. Early intermediate group of eggs. Taken from a newly extruded "spent") female, 6.0 cm. long, collected from Cagayan River, Oriental Misamis Province, August 21, 1940 (×1000): *im*, immature eggs; *it*, intermediate eggs.

2. Maturing or advanced intermediate group of eggs. Taken from a maturing female anga, 5.5 cm. long, collected from Cagayan River, Oriental Misamis Province, August 21, 1940. (×1000); *m*, maturing eggs.

3. Mature or ripe group of eggs. Taken from a spawning female anga, 6.6 cm. long, collected from Cagayan River, Oriental Misamis Province, August 21, 1940 (× 1000): *rp*, ripe eggs.

4. A cluster of newly laid eggs of anga, *Sicyopterus extraneus* Herre (×112).

5. A newly-laid egg (unfertilized), (×150); 5*a*, calyxlike attachment of gelatinous threads.

6. Early blastodermal cap stage at approximately 3 hours after laying.

7. Completed blastodermal cap stage at approximately 7 hours after laying.

8. "Segmentation cavity" and early germ ring stage, approximately 9 hours after laying: *gr*, germ ring; *sc*, "segmentation cavity".

9. Embryonic shield stage, approximately 11 hours after laying: *es*, embryonic shield.

10. Primitive streak stage, approximately 12½ hours after laying; *ps*, primitive streak.

11. Advanced embryo with 3 to 4 somites, approximately 13½ hours after laying. Note the thoraco-ventrally located heart (*h*).

12. Advanced embryo with increased number of somites, approximately 16 hours after laying. Note the differentiation of the optic vesicles (*c*).

13. Fully developed embryo shortly before hatching, approximately 22 hours after laying.

14. Newly hatched larva, approximately 23 hours after laying (×200).

15. Swimming larva, about 3 hours after hatching (×236).

16. Two-day-old larva (×147).

17. Three-day-old larva (×125).

PLATE 2

FIG. 1. Facial view of abdominal cavity of a spawning female anga. Note the space occupied by the ripe ovary (×6): Ov, ovary; *gp*, genital papilla.

2. A batch of newly-laid eggs still attached to the stone substrate (½ actual size): *me*, mass of eggs; *s*, stone.

3. Muli fry (× 8).

4. Hipon fry (× 7).

5. Ankal fry (× 7).

PLATE 3

FIG. 1. Adult male *Sicyopterus* (× 2).

2. Adult female *Sicyopterus* (× 2).

TEXT FIGURES

FIG. 1. Average monthly landings (1937–1939) in Cagayan, Oriental Misamis Province (data based on 5 baling outfits).

2. Summary of Sicyopterus spawning season in Cagayan River as indicated by the percentage relation between spawning females and all females.

3. Comparison between the monthly catch and the spawning season.

4. Diameter frequencies of 300 ova, each taken from the three developmental stages of the ovary, all collected on August 21, 1940, from Cagayan River; (*a*) "spent" female, 7.4 cm. long; (*b*) intermediate or early maturing female, 7.3 cm long; and (*c*) ripe female, 6.9 cm. long.

5. Showing the sign when maturity occurs. The solid line represents the percentage of maturing females and the broken lines the percentage of males which mature at the indicated sizes.

6. Body length frequencies of males and female Sicyopterus (data based on all materials collected during the period of investigation).

7. Graphic estimation of the significance of the difference between the average body lengths of male and female Sicyopterus.

8. Total body length frequency polygons of about 300 each of muli, hipon and ankal fry.

9. Average monthly duration in days of hipon and muli fry runs in Cagayan River, Oriental Misamis Province.

10. Monthly lunar periods (1938–1939) and duration of hipon and muli fry runs in Cagayan River, Oriental Misamis Province.

A CONTRIBUTION TO THE KNOWLEDGE OF THE STRUCTURE AND COMPOSITION OF THE WATER MASSES OFF EASTERN PHILIPPINES

By T. G. Megia and D. V. Villadolid
Of the Bureau of Fisheries, Manila

FOUR TEXT FIGURES

The water masses found in the Eastern Philippines have been classified into three distinct bodies based on temperature-salinity relationship, namely, the Western North Pacific Central, water, the Pacific Equatorial water, and the North Pacific Intermediate water. However, the North Pacific Intermediate water mass has been excluded from this analysis because its temperature-salinity relationships are not as clear cut as those of the first two and its position in the water column is such that it vitiates the determination of percentage composition.

The westerly North Pacific Equatorial Current carries these water masses into the waterways and inland seas of the Philippines, either directly or indirectly through the South China Sea to the west or the Celebes Sea to the South. An analysis then of the structure and composition of these water masses prior to their entry into the fishing areas of the Philippines will fill the need for understanding the physical factors that define the normal patterns of marine ecology of these fishing grounds. The importance of this knowledge is, therefore, fundamental to fisheries investigations in the Philippines.

SOURCE OF DATA

The analysis presented in this report has been made possible with the free use of the *Spencer F. Baird* data collected in 1947–50 by the United States Fish and Wildlife Service. It was the plan in the beginning to include temperature and salinity data from other sources, principally those collected from the same or adjacent areas by Japanese research ships. But after examination of these observations, a great number of the salinities disclosed discrepancies which could not be explained. Observations made by other investigators are either too few or unavailable. The *Baird* data, however, have been found to be amply sufficient for the purposes of this analysis.

METHODS

The temperature-salinity diagram method, first introduced by Helland-Hansen (1918) and later extensively used by others in separating and characterizing the water masses in the sea, has proved to be a valuable aid in oceanography. The T–S diagram itself serves as a means for identifying the physical properties of a given water mass and tracing its origin and transformation by physical processes. It affords a quick survey of stability conditions within the water column (Jacobsen, 1929). Finally, it discloses intrinsic evidences of probable error of observation and transposition of data (Parr, 1935).

The T–S diagram is in reality a graphical representation of temperature and salinity on a rectangular coordinate system in relation to two parameters, namely, depth and time (Stockman, 1946). When thus plotted, corresponding temperature and salinity values for any given time arrange themselves according to depth. This singular arrangement of the points into a well-defined curve distinguishes one water mass from another.

On the basis of the T–S relations of the principal water masses of the oceans (Sverdrup, 1943), the Western North Pacific Central water and the Pacific Equatorial water may be defined by their salinities at stated temperatures as follows:

Western North Pacific Central Water				
10°	12°	14°	16°	
34.24±0.07	34.38±0.06	34.52±0.06	34.67±0.07	
Pacific Equatorial Water				
6°	8°	10°	12°	14°
34.56±0.05	34.60±0.05	34.72±0.07	34.86±0.06	35.05±0.06

These values were plotted as narrow bands in text fig. 4; in text fig. 1 only the mean salinities were paired with the temperatures. On account of the fact that both water masses are found at depths to which seasonal changes may no longer be effective, their T–S curves may be used in this analysis irrespective of the seasons.

A convenient and effective method for determining the composition of varying mixtures of the two water masses is graphically presented in text fig. 1. This method is an adoption of a similar scheme introduced at the Scripps Institution of Oceanography for determining the percentage composition of the two water masses found off Western California. The two bold lines drawn on each side of the measuring scale were derived, as has already been mentioned in the beginning, from

the curves drawn by Sverdrup (1943). That on the left side represents the mean curve of the temperature-salinity relationships of the Western North Pacific Central water, while that on the other side those of Pacific Equatorial water. In the area of transition enclosed by the two boundary curves, lines

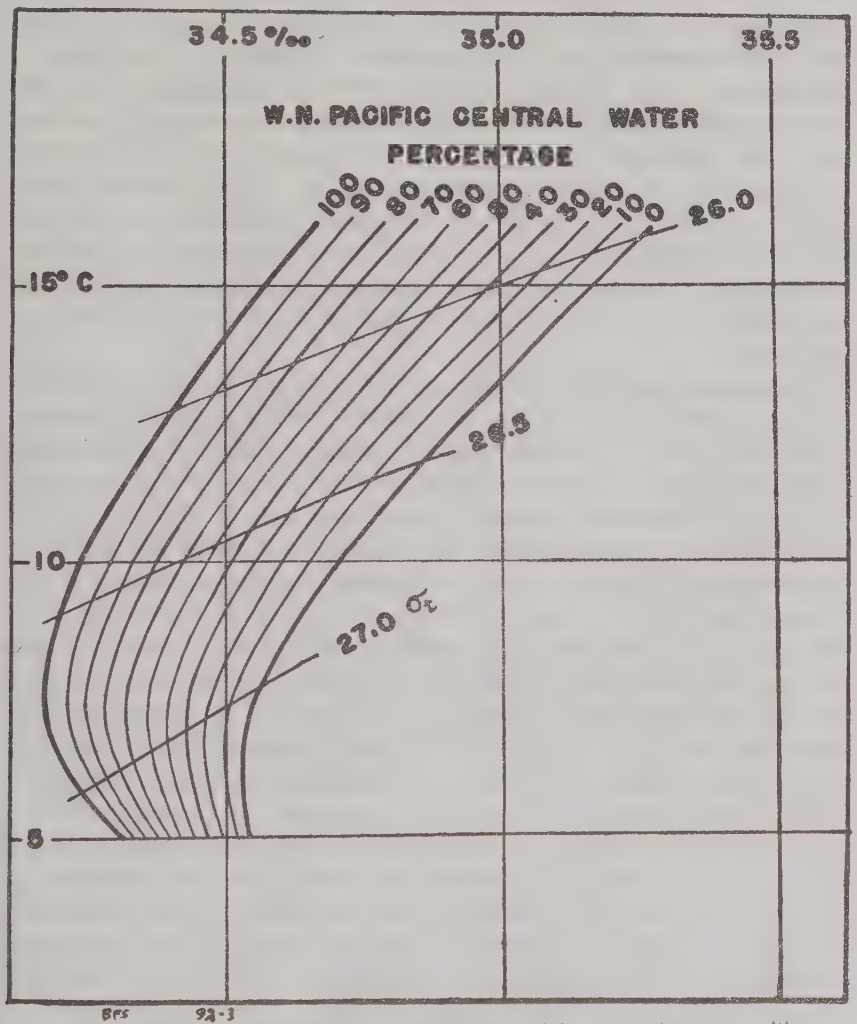


FIG. 1. Showing the measuring scale used in determining percentage composition.

corresponding to percental proportions of the water masses were drawn. The spacing was based on the isopycnals which were entered to indicate the probable paths along which lateral mixing is assumed to take place. These isopycnals were referred to the pressure of one atmosphere and were thus labelled as sigma-t surfaces, which are here assumed to depart insignifi-

cantly from the true isentropic surfaces. The temperatures, however, were not referred to the same pressure as very little advantage could be gained thereby for the purposes of this work.

The temperature and salinity relationships of the surface layers are of little physical significance and, therefore, have been excluded from the analysis. The lower layers have likewise been omitted for two reasons. Firstly, as the area of transition narrows down to the point of convergence of the two boundary curves, the scaling becomes increasingly inaccurate and, secondly, the effects of the presence of a third water mass, already referred to previously as the North Pacific Intermediate water, will naturally introduce uncertainties in the percentage values scaled from the lower part of the area of transition. Consequently, the analysis has been confined to that part of the water column between the depths of 300 and 600 meters.

The measuring scale was drawn on a transparent sheet which was superimposed upon the individual T–S curves for scaling. For every pair of temperature and salinity values, a percentage value was read off from each standard depth. For instance, at a certain standard depth a water mixture of 15°C. and 35.0 o/oo contains about 28 per cent Western North Pacific Central water and 72 per cent of Pacific Equatorial water, while at another standard depth water of 10°C. and 3.44 o/oo is a 50–50 mixture of the two water masses. The means of all the values thus scaled from each individual curve were entered on the horizontal plan shown in text fig. 2, and then smooth lines connecting the same values were drawn. It is worthy to mention at this point that no definite limits in the accuracy of the scaled percentages can be assigned on account of the many factors involved which cannot be quantitatively determined. Therefore, the percentages should not be regarded as representing absolute values. The precision of the measurements is, however, remarkable as the results can easily be reproduced. Hence, there is confidence in the belief that the results have a fair relative correctness.

DISCUSSION OF RESULTS

It is readily seen from text fig. 2 that the percentage composition of the mixture of the two water masses rather regularly increases northward with respect to the Western North Pacific Central water. The somewhat complex picture seen in the

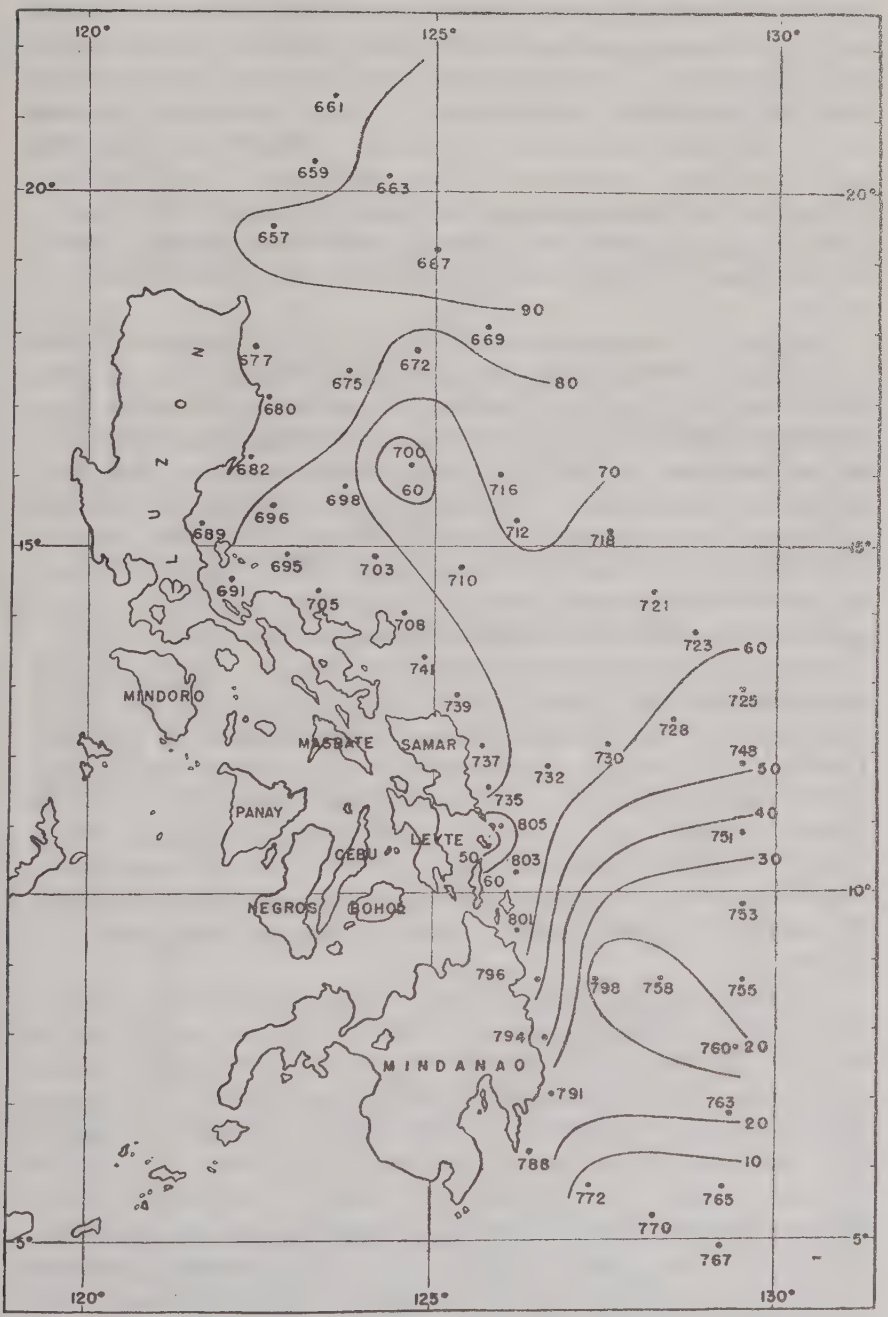


FIG. 2. Showing the percentage composition of the waters off eastern Philippines with respect to the Wester North Pacific Central water and the Pacific Equatorial water.

vicinity of the 10° N. latitude suggests the effects of the great North Pacific Equatorial Current, as it hits the eastern flank of the Philippines which divides it into its northern and southern components. The small pocket of water of about 60 per cent in composition located east of Luzon and north of the 15° N. latitude presumably represents a broad and deep eddy at the surface. In the area to the northeast of Luzon the composition of the water mixture is close to 90 per cent of Western North Pacific Central water which, with respect to the area to the southeast of Mindanao, is represented by Pacific Equatorial water.

Text fig. 3 discloses interesting details of the character of the two current systems dominating Eastern Philippines. Anomalies of dynamic heights expressed in dynamic centimeters were referred to the 2,000-decibar surface. Pressure units expressed in decibars may be taken as numerically equal to depths expressed in linear meters. Thus, pressures of 300, 400, 500 and 600 decibars correspond to geometric depths of 300, 400, 500 and 600 meters, respectively. A knowledge of this numerical equality between two entirely different dimensions is helpful in interpreting the pictures delineated by the profiles in text fig. 3.

The curve shown cutting across the isobaric surfaces defines approximately the position of the line of contact of the North Pacific Equatorial Current and the Pacific Equatorial Counter-Current. The first is represented on the northern or left side of the line and the second on the southern or right side. The rising isobaric surfaces to the left indicate that the North Pacific Equatorial Current flows westward toward the observer, while those to the right of the line indicate that the Pacific Equatorial Counter-Current moves eastward away from the observer.

The upper profile in fig. 3 further shows that in the surface layers the southern edge of the westerly current lies somewhere between B–760 and B–763, but at greater depths above, about 400 meters, it is displaced progressively northward. This shows that the Pacific Equatorial Counter-Current widens with depth. The fact that this is so in Eastern Philippines upholds the views of Defant and Krummel, as cited by Sverdrup (1944), but contradicts those of Sverdrup himself, who, on the basis of the Carnegie data, maintains that the breadth decreases with depth. In this respect the Japanese and "Crossroads" data of the Marshall Islands area presented by Barnes, Bumpus, and Lyman (1948) corroborate the Carnegie data collected south-

east and southwest of the Hawaiian Islands at about the same latitude as that for the *Baird*, the Japanese and "Crossroads" data. This fact appears to indicate that the boundary between the west and east-setting currents is maintained latitudinally across the Pacific Ocean. It appears to be approximately at 7° or 8° N. latitude.

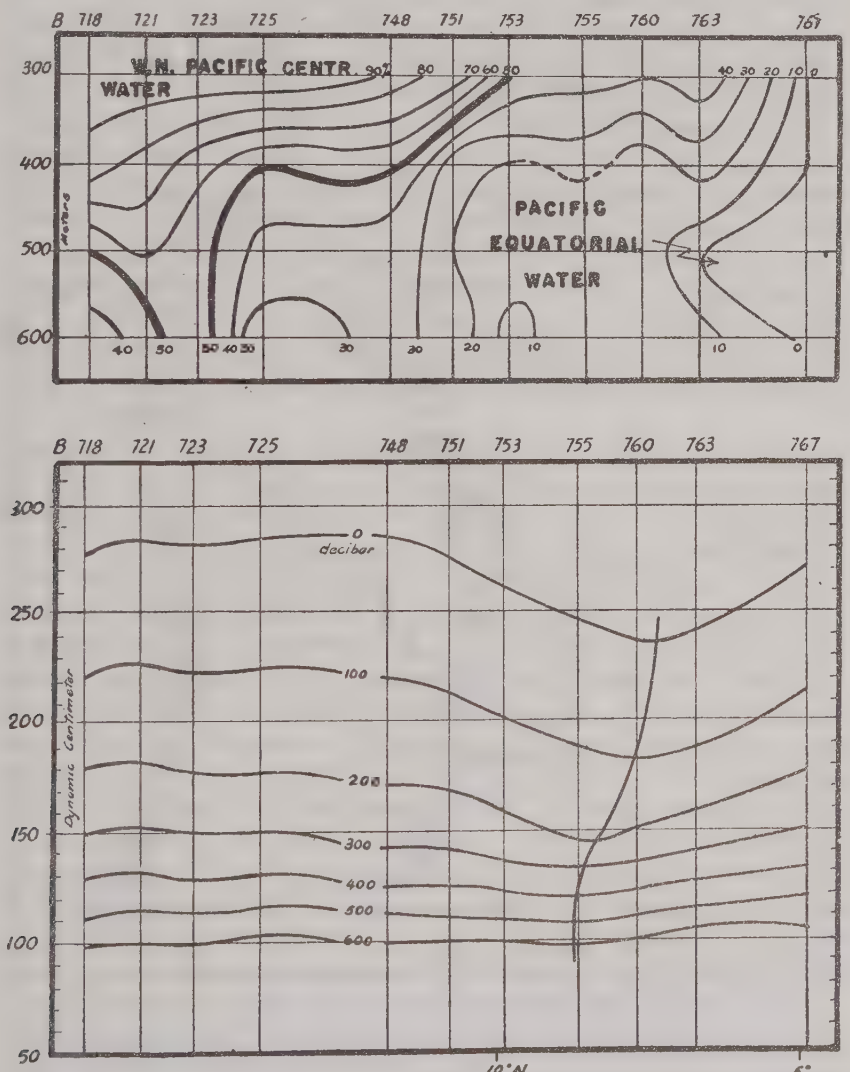


FIG. 3. Showing the dynamic topography and the percentage composition in a vertical section.

As shown by the slopes of the four isobaric surfaces, the strength of both currents is greatly diminished beginning at 300 meters, the upper boundary of the water column considered

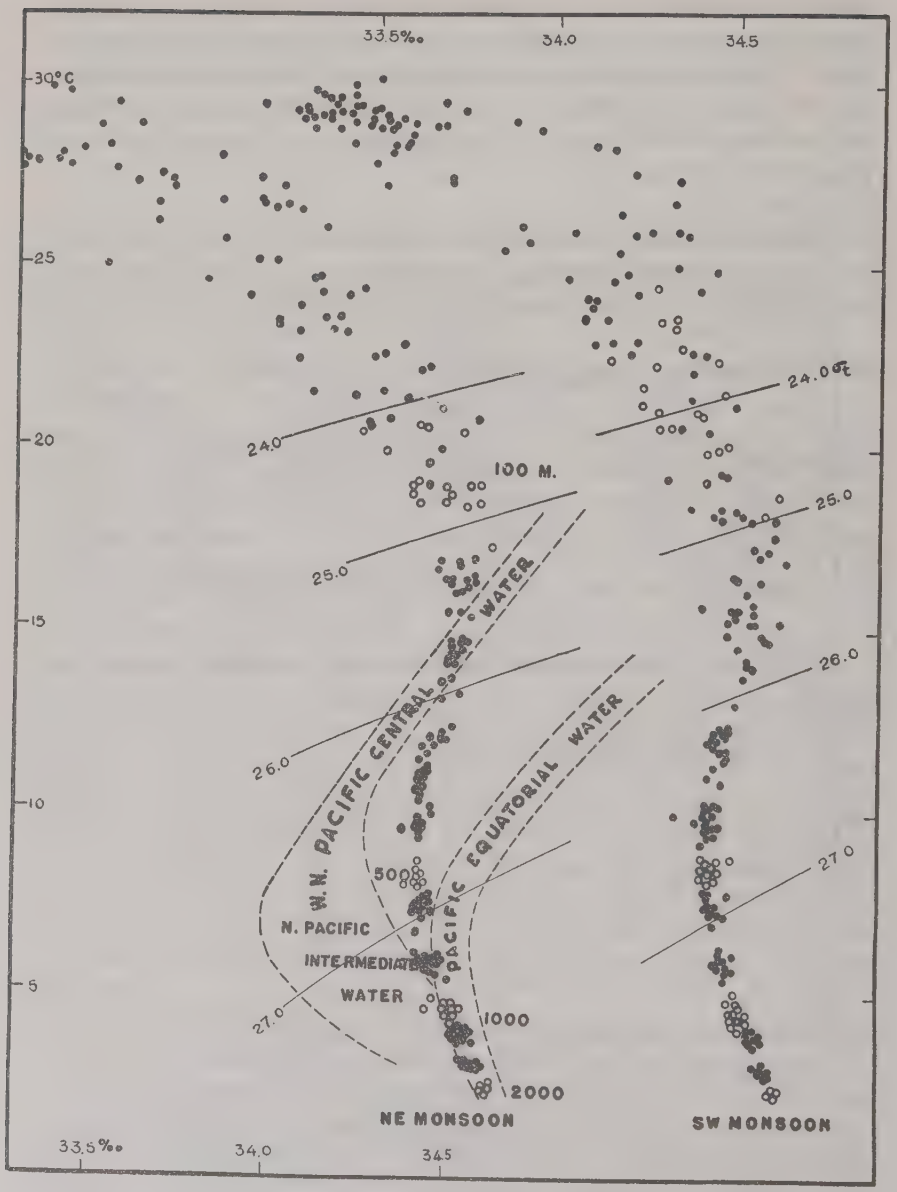


FIG. 4. Showing a composite picture of the T-S relations for the two monsoon periods.

in this analysis. The reverse slopes of the isobaric surfaces shown at the extreme left-hand side serve to confirm the statement made previously regarding the presence in the vicinity of that area of a large cyclonic eddy of great vertical extent.

The lower profile shows that while the percentage composition increases with increasing latitude it decreases with increasing depth. Essentially, this means that as one proceeds northward within the area covered by this work, the lighter Western North Pacific Central water increases in thickness as the Pacific Equatorial water sinks to greater depths. This seems to be a characteristic feature of the waters of the Western North Pacific Ocean where both kinds of water masses are present. Barnes, Bumpus, and Lyman (1948) reported the same feature.

The presence of a large body of water of nearly uniform composition within the area of contact of the two currents is suggestive of the churning action of the two currents moving in opposite directions. South of B–763 at about a depth of 500 meters an intrusion of the Pacific Equatorial water crosses the 5° N. latitude.

After dealing with the characteristics of the water masses in that part of the water column which easily lends to this method of analysis, it is now logical to turn to the structure of the upper part of the water column. In this connection, it was stated in the beginning that the surface layers were of little physical significance in this study. The reason for this is that seasonal variations and local effects tend to obscure or mask the true temperature and salinity relationships. Monsoonal variations in the physical properties of the surface layers of the waters of Eastern Philippines appear to be rather well-marked as shown in text fig. 4, which shows the temperature-salinity relationships during the two different seasons. The compactness of the points above the 25.0 sigma-t line in the scatter diagram for the northeast monsoon season is in contrast to the wide dispersion of the corresponding points in the scatter diagram for the southwest monsoon period. It is on account of this fact that the depth of 300 meters was chosen as the upper boundary of the water column considered in this analysis. The figure shows that below this depth the monsoonal fluctuations in the character of the surface layers are no longer effective.

A closer examination of the two scatter diagrams will reveal the fact that two significant layers of salinity maximum and salinity minimum are found within the entire water column.

The layer of salinity maximum appears to coincide with the 24.0 sigma-t line during the northeast monsoon period. During the other season this layer is also quite evident, but its position in relation to any isopycnal is not so clear-cut.

SUMMARY

The Western North Pacific Central Water increases in thickness with increasing latitude as the Pacific Equatorial Water sinks to greater depths. This trend is interrupted only by the presence of an eddy east of Luzon.

The Pacific Equatorial Current widens with depth in Eastern Philippines; the boundary between this current and the North Pacific Equatorial Current is maintained latitudinally at approximately 7° or 8° N.

A layer of salinity minimum is found below the subsurface layer of salinity maximum. The layer of salinity minimum has a salinity less than 34.5 o/oo and a temperature range of 5–10° C., while the other layer has a salinity greater than 35.0 o/oo and a temperature range of 20°–25°C.

ACKNOWLEDGMENT

Dr. Herbert W. Graham, Chief, North Atlantic Fishery Investigations and formerly Oceanographer-in-Charge of the Philippine Fishery Program which collected the data used in this report, has given valuable advice and suggestions after going over the original manuscript. We are grateful for this help.

REFERENCES

Barnes, C. A., D. F. Bumpus, and John Lyman.
Ocean circulation in Marshall Islands area. Trans., American Geophysical Union. 29 No. 6 (1948) 871–876.

Jacobsen, J. P.
A contribution to the hydrography of the North Atlantic. The Danish *Dana* Expedition. 1920–1922, No. 3, Copenhagen (1929).

Parr, Albert E.
Report on hydrographic observations in the gulf of Mexico and adjacent waters made during the Yale Oceanographic expedition on the "Mabel Taylor" in 1932. Bull. of the Bingham Oceanographic Collection 5 Art. 1. New Haven, Connecticutt (1935).

Stockman, W. B.
A theory of T–S curves as a method for studying the mixing of water masses in the sea. Jour. of Marine Research. 6 No. 1 (1946).

SVERDRUP, H. U.

Scientific results of the Cruise VII of the *Carnegie* during 1928–1929, under the command of Captain J. P. Ault. II. Results within physical oceanography. Carnegie Institution of Washington Publication 545. Washington, D. C.

SVERDRUP, H. U.

Oceanography for meteorologists (1945) 1–246. Prentice-Hall, Inc., New York.

TIBBY, RICHARD B.

The water masses off the west coast of North America. Scripps Institution of Oceanography. New Series No. 141, La Jolla, California (1941).

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Showing the measuring scale used in determining percentage composition.

2. Showing the percentage composition of the waters off eastern Philippines with respect to the Western North Pacific Central water and the Pacific Equatorial water.

3. Showing the dynamic topography and the percentage composition in a vertical section.

4. Showing a composite picture of the T–S relations for the two monsoon periods.

FOOD HABITS OF TUNAS AND DOLPHINS BASED UPON THE EXAMINATION OF THEIR STOMACH CONTENTS [1]

By INOCENCIO A. RONQUILLO
Of the Bureau of Fisheries

TWO TEXT FIGURES

INTRODUCTION

Although tunas are reported to be commercially present in the Philippines, yet they are still unexploited. They constitute a potential source of food supply and certainly a very promising segment of Philippine fisheries from which to develop overseas export trade. Any attempt, therefore, to study the biology of these fish will reflect to the ways and means to catch them wisely and effectively.

Kishinouye (1917) studied the stomach contents of 141 specimens consisting mostly of yellowfins, albacores, and big-eyed tuna which were taken from the region between the Bonin Island and Iwo Jima. Among the food items he found were many deep-sea species of fishes and some invertebrates. He described the phyllosoma juveniles of spiny lobsters, larval forms of the sunfish (*Mola mola*) and juveniles of big-eyed tuna and albacore. He further noted that these voracious fishes will take the hook even when their stomachs are almost full of food. He remarked: "The digestive powers of the tunas are amazing. It appears that in their stomachs the animals quickly lose their original form, and it is difficult to recover a specimen in perfect condition from the stomach contents."

Nakamura (1936) listed 17 families of fishes represented in the stomachs of 57 yellowfin tuna, *Neothunnus macropterus*, from the Celebes Sea. He found that the most important natural food of this species consists of fishes, followed by squids among the mollusks, and stomatopods among the crustaceans. Most of the fishes that he found belonged to the following genera: *Engraulis*, *Ostracion*, *Balistes*, *Sphyræna*, *Stolephorus*, and *Leiognathus*. Other scombroids were also represented. Like Kishinouye, he doubted if there is a point of satiation in the feeding habits of yellowfin tuna or if it selects any particular food.

[1] Submitted to the Third Meeting of the Indo-Pacific Fisheries Council held in Madras, India, from February 1 to 16, 1951.

Very little study in the Philippines has been undertaken on the biology of tunas. Wade (1948) made studies of the juvenile forms of tunas and was able to establish their probable spawning areas in this country.

The present paper presents a report on the feeding habits of Philippine tunas caught by trolling based upon the examination of their stomach contents.

MATERIALS AND METHODS

During the various technical cruises of the research vessels *Spencer F. Baird* and *Theodore N. Gill* of the Philippine Fishery Program, U. S. Fish and Wildlife Service, the former from September, 1947 to June, 1949, caught by trolling, pelagic fishes, mostly tunas. The stomach contents of 304 tunas and 25 dophins collected by the *Baird,* and those of a yellowfin tuna and one dolphin taken by the *Gill* were saved and examined. The fork lengths and weights of the tunas were taken and the viscera were removed by splitting the belly of the fish. The stomach of each fish was immediately opened and the contents sorted, labelled, and wrapped with cheese-cloth. The specimens were preserved in a 10 per cent formalin solution and later in 70 per cent alcohol. They were later transferred into individual containers.

It was noted that most of the specimens examined had empty stomachs. The tunas were caught from the southern part of the Philippines, particularly in the vicinities of Sulu Sea, Davao Gulf, Busuanga Strait, and Celebes Sea.

The stomach contents were emptied into Petri dishes and the animal components were identified and enumerated. Records of standard or total lengths of fish specimens were taken. The food items and the quantity of each kind taken from each tuna were indexed together with the pertinent data about the fish. The unidentified juvenile fishes, too, were grouped together.

TABLE 1.—*Number of stomachs examined for each species of tuna.*

Species	No. of stomachs
Yellowfin tuna, *Neothunnus macropterus* (Temm. and Schl.)	115
Skipjack, *Katsuwonus pelamis* (Linn.)	115
Oceanic bonito, *Euthynnus yaito* Kishinouye	75
Dolphin, *Caryphæna hippurus* Linn.	26

RESULTS AND DISCUSSION

Fig. 1 gives a graphic representation in percentage of the types of food which these fishes feed on.

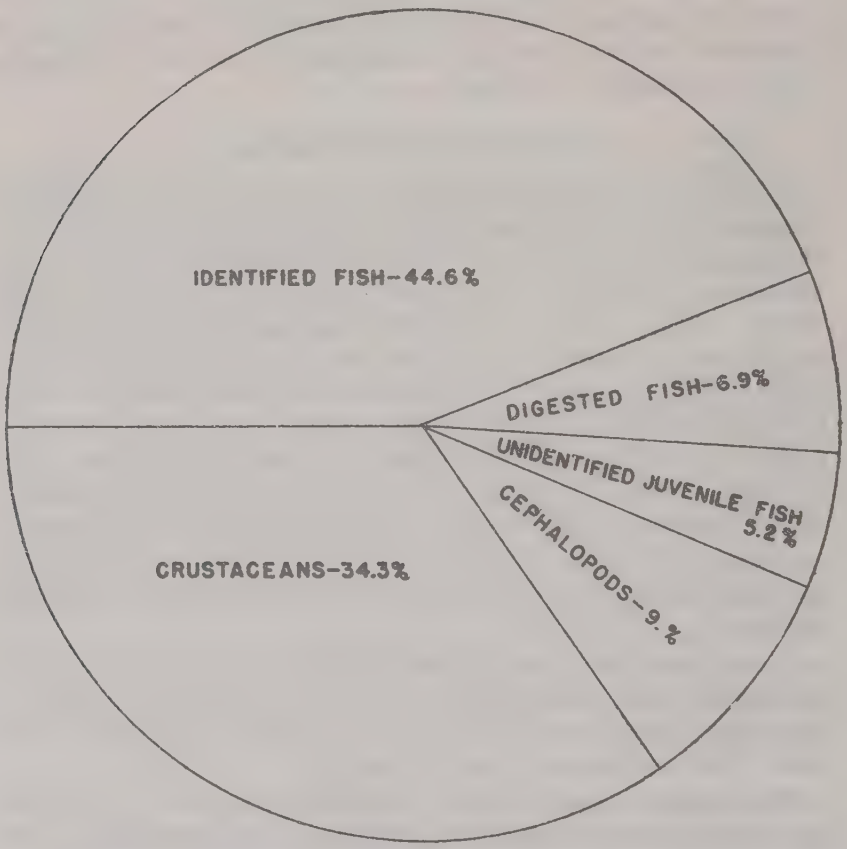


FIG. 1. Percentage of food items of Philippine tunas and dolphins determined on the basis of numbers found in the stomachs.

IDENTIFIED FISHES.—Fishes identified as to their respective families, genera, or species including seven tests of pelagic tunicates.

FISH REMAINS.—Unidentified fishes due to either partial or complete mutilation. The skulls and the vertebral columns were used in enumerating them.

JUVENILE FISHES.—Unidentified larvæ and juveniles which would be studied separately.

CEPHALOPODS.—Squids were the most common of the mollusks; however, some baby octopuses and paper nautiluses (*Argonauta*) were recovered. Some pteropods were included in this group.

CRUSTACEANS.—The megalopa larva of crab was second only to the larval and juvenile stomatopods. Zoea larvæ were also found in fair quantities as well as some shrimps, amphipods, phyllosoma larvæ of spiny lobster, some barnacles, and young crabs.

The analyses revealed the following kinds of fish and other organisms recovered from the stomachs of these pelagic species. Fig. 2 gives a graphic representation in percentage of the different orders included in the identified fishes recovered.

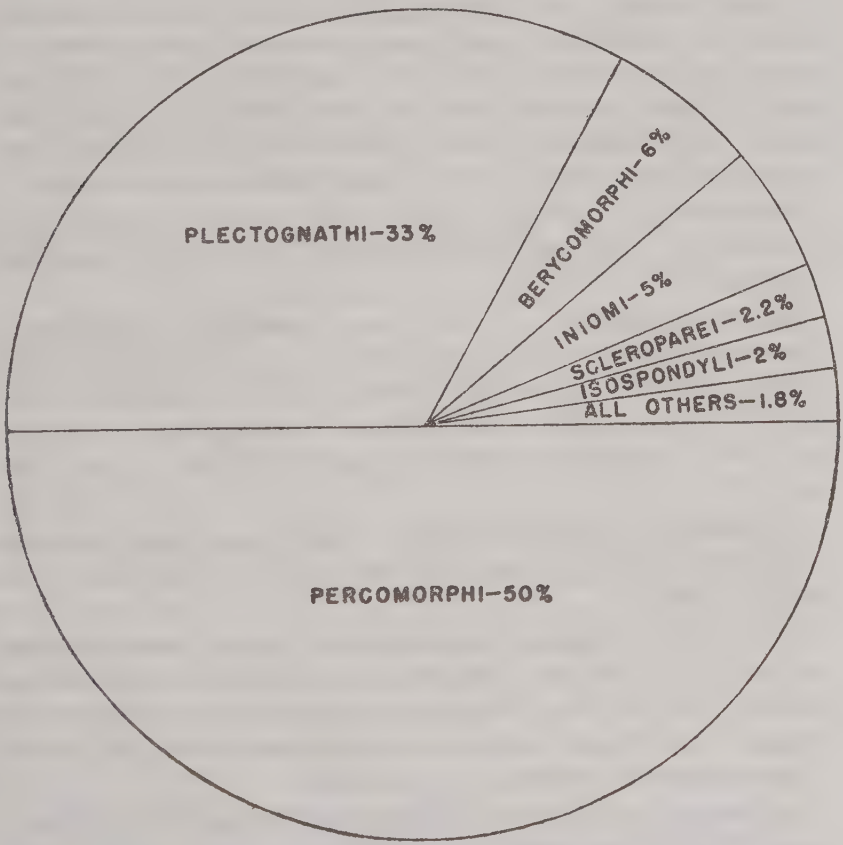


FIG. 2. Percentage of identified fish food items recovered from stomachs of Philippine tunas and dolphins.

PERCOMORPHI.—The *Acronurus* larvæ of the surgeon fish (Teuthididæ) were apparently the most common percomorph encountered. A collection of these larvæ and juveniles ranging from 10 mm to 45 mm in standard length was saved for further study. It is possible that some of these larvæ are those of other related species. Juveniles of the cutlass-fish, *Trichiurus*,

were occasionally found in quantities in some of the stomachs examined. Juveniles of both the pelagic and deep-sea species such as *Auxis, Caranx, Decapterus, Gempylus,* bramids, and chiasmodontids were found very often. Other percomorphs including the group of fishes which normally live near the shore and among the coral reefs were recovered. Among these were *Caesio, Siganus,* goat fishes (Mullidæ), butterfly-fishes (Chaetodontidæ), damsel fishes (Pomacentridæ), a wrass (Labridæ), and a parrot-fish (Scaridæ).

PLECTOGNATHI.—The plectognaths which were considered useless and poisonous, form a great bulk of the food item of these wanderers of the sea. The horn-fishes (Triacanthidæ) were the most common forms of this group followed by file-fishes (Monacanthidæ), and trigger-fishes (Balistidæ). Occasionally, *Tetraodon, Ostracion,* and *Diodon* were also eaten.

BERYCOMORPHI.—Those recovered were all soldier-fishes (Holocentridæ). Most of these were *Holocentrus* while some were *Myripristis.*

INIOMI.—Contrary to what was expected, lantern-fishes (Myctophidæ) were recovered only twice from the stomachs of tunas. However, in one *Euthynnus yaito,* 65 of them were recovered. Some juvenile lizard-fishes (Synodontidæ) were also seen. Five *Lestidium philippina* and two *Sudis rissoi* were saved.

SCLEROPAREL.—Flying gurnards (Dactylopteridæ) were recovered occasionally, and flat-heads (Platycephalidæ) were recorded twice.

ISOSPONDYLI.—Most of the soft-rayed fishes were sardines, *Sardinella,* and the deep-sea hatchet fish, *Sternoptyx diaphana.* However, a few round herrings (Dussumieridæ), two *Astronesthes,* one *Omosudis lowei,* and a stomiastid were recovered. A pair of chauliodontid jaws were saved.

ALL OTHERS.—This group included pipe-fishes (Syngnathidæ), cornet-fishes (Fistularidæ), shrimp-fishes (Centriscidæ), garfishes (Belonidæ), half-beaks (Hemiramphidæ), flying-fishes (Exocoetidæ), sea-moths (Pegasiidæ), an antigonid, and a *Leptocephalus* larva.

Table 2 indicates the various types of food consumed by tunas and dolphins and gives an adequate picture of the relative importance of each food in the diet.

TABLE 2.—*Food classes consumed by tunas and dolphins, their total frequency of occurrence and percentage of occurrence*

Fish	Total No. occurring	Frequency of occurrence	Percentage of occurrence
Spiny-rayed fishes (Percomorphi)	1,248	347	25.23
Horn-fishes, file-fishes, trigger-fishes, etc. (Plectognathi)	823	187	13.60
Squirrel fishes (Holocentridæ)	149	46	3.34
Flying gurnard and flat-heads (Scleroparei)	55	28	2.04
Herring-like fishes (Isospondyli)	52	52	1.82
Lizard fishes, lantern fishes (Iniomi)	127	21	1.53
All others (Flying fishes, pipe fishes, Hemirlamphids)	51	18	1.31
Unidentified larval fishes	294	69	5.01
Fish Remains	389	121	8.81
Cephalopoda			
Squids, *Octopus* and *Argonauta*	504	113	8.22
Crustacea			
Larval and juvenile sea-mantis (Stomatopoda)	884	161	11.71
Crab larvæ (Zoea, megalopa, and phyllosoma of spiny lobster)	836	155	11.27
Crabs and shrimps	129	47	3.42
Sea fleas (Amphipoda)	72	37	2.69
	5,613		100.00

Tunas apparently do not choose their food. They eat any swimming animal available. Fish evidently form the most important food item of tuna (fig. 1). This is clearly shown by the fact that 51 families of fishes representing 11 orders were recovered from the stomachs of these pelagic fishes. Pelagic, demersal, shore and coral reef fishes as well as deep-sea species were used as food. Spiny-rayed fishes form the most important food item of tuna and dolphins in Philippine waters. This is to be expected since they are found in open waters and coral reefs. The presence of shore and reef fishes in the stomachs of these tuna indicates that they go near the shore either to forage or to follow their prey of small pelagic fishes and later eat whatever fishes that are found in the area. This is probably the reason why tuna are caught in fish corrals specially constructed for this purpose along the coasts of Batangas and Zamboanga Peninsula.

Among the juvenile fishes which frequently appeared besides the *Acronurus* larvæ were *Caranx*, *Holocentrus*, *Gempylus*, *Auxis*, *Dactyloptena*, *Trichiurus*, balistids, monacanthids, tetraodontids, triacanthids, chaetodontids, and bramids.

The most important single item of food of these pelagic species both in number of occurrence and number of individuals consists of the juveniles and larvæ of sea mantis (Stomatopoda). These are followed by the pelagic forms of squids among the mollusks and crab larvæ such as zoea and megalopa, among the crustaceans.

Some pelagic and deep-sea fishes which were either rare or encountered for the first time from the Philippine waters were recorded. Most of these specimens were partially digested and in a few cases only certain morphological characteristics of the body, namely, skull and dentition, were used to assign them to their respective families. However, almost perfect specimens of Sudidæ, Bramidæ, Tetragonuridæ, Antigonidæ, *Seriola nigrofasciata*, *Zanclus canescens*, *Gemphylus serpens*, and *Xiphasia setifer* were saved. Table 3 shows a list of these fishes.

TABLE 3.—*Rare and deep-sea fishes found in the stomachs of Philippine tunas and dolphins*

Name of fish	No. recovered		Species from which recovered
Astronesthidæ (?) ..... 50 mm S.L.	2	(partly mutilated)	*E. yaito.*
Chauliodontidæ (?)	1	(jaws only preserved) (some in good condition)	*K. pelamis.*
Sudidæ			
Lestidium philippina (Fowler)	2		*N. macropterus.*
50–99 mm S.L.	2		*K. pelamis.*
Sudis rissoi Bonaparte [a] 240 mm S.L.	2	(skinned)	*E. yaito.*
Bramidæ			
Collybus drachme Snyder [a]	3		*N. macropterus.*
23.72 mm S.L.	3		*K. pelamis.*
Unidentified	3		*N. macropterus*
10–55 mm S.L.	10		*K. pelamis.*
Teuthididæ	225	(plenty in very good condition)	*N. macropterus.*
Acronurus larva	113		*K. pelamis.*
10–45 mm S.L.	6		*E. yaito.*
	4		*C. hippurus.*
Tetragonuridæ			
Tetragonurus cuvieri [a] Risso 33 mm S.L.	1	(excellent condition)	*N. macropterus.*
Stomatidæ ..... 83 mm S.L.	1	(partly digested)	*K. pelamis.*

[a] First record in Philippine waters, to be reported later.

TABLE 3.—*Rare and deep-sea fishes found in the stomachs of Philippine tunas and dolphins*—Continued.

Name of fish	No. recovered	Species from which recovered
Omosudidæ		
Omosudis lowei Günther 82 mm. S.L.	1 (partly digested)	*K. pelamis.*
Sternoptychiidæ		
Sternotyx diaphana Hermann	4 (some in fair condition)	*N. macropterus.*
	25	*K. pelamis.*
15–39 mm S.L.	1	*E. yaito.*
Antigonidæ		
Antigonia 36 mm S. L.	1 (in good condition)	*N. macropterus.*
Carangidæ		
Seriola nigrofasciata (Ruppell) 47 mm S. L.	1 (in good condition)	*N. macropterus.*
Chiasmodontidæ	4 (in good condition)	*N. macropterus.*
30–47 mmS.L.	3	*K. pelamis.*
Zanclidæ		
Zanclus canescens Linn. 20–60 mm S.L.	3 (in good condition)	*C. hippurus.*
Gempylidæ	3 (in good condition)	*N. macropterus.*
Gempylus serpens C.&V.	12	*K. pelamis.*
35–170 mm S.L.	1	*E. yaito.*
Rexia solandri (*Cuvier*)	1 (some in fair condition)	*C. hippurus.*
		N. macropterus.
78–124 mm. S. L.	9	*K. pelamis.*
Xiphasiidæ		
Xiphasia setifer Swainson	1 (in good condition)	*N. macropterus.*
	1	*E. yaito.*
240–322 mm S.L.	1	*C. hippurus.*

TABLE 4.—*List of organisms recovered from the stomach of tunas and dolphins*

Name of fish	*N. macropterus*	*K. pelamis*	*E. yaito*	*C. hippurus*	*Total*
Order Isospondyli:					
Clupeidæ		5	4	1	10
Sardinella		8			8
Dussumieriidæ				2	2
Sternoptychiidæ					
Sternoptyx diaphana Hermann	4	24	1		29
Astronesthidæ					
Astronesthes			2		2
Stomiatidæ		1			1
Order Iniomi:					
Synodontidæ	5	28		1	34
Sudidæ					
Lestidium philippina (Fowler)	2	2			4
Sudis rissoi Bonaparte			2		2
Myctophidæ	1	21	65		87

TABLE 4.—*List of organisms recovered from the stomachs of tunas and dolphins*—Continued

Name of fish	*N. macropterus*	*K. pelamis*	*E. yaito*	*C. hippurus*	Total
Order Apodes:					
Leptocephalus larva		1			1
Order Synentognathi:					
Belonidæ				3	3
Heramphamphidæ		2	2	3	7
Exocoetidæ	12	3		4	19
Order Solenichthyes:					
Fistulariidæ		2			2
Centriscidæ	1				1
Syngnathidæ	3	3	1	1	8
Order Berycomorphi:					
Holocentridæ	24	115	3	7	149
Order Zeomorphi:					
Antigoniidæ		1			1
Order Percomorphi:					
Priacanthidæ	5	4	1	1	11
Lactariidæ	5				5
Carangidæ	39	44	5	3	91
Caranx sexfasciatus Q. & G.	11			1	12
Decapterus	9	7	21	3	40
Seriola nigrofasciata (Rüppell)	1				1
Megalaspis cordyla Linn.		1	1		2
Menidæ					
Mene maculata (Bl. & Schn.)			23		23
Bramidæ	6	13			19
Coryphaenidæ					
Coryphaena hippurus Lac.		1		3	4
Lutianidæ					
Caesio		1	8		9
Polynemidæ	1				1
Mullidæ	25	13		32	70
Scatophagidæ	2				2
Chaetodontidæ	15	23	1		39
Pomacentridæ	8	12	1		21
Scaridæ				1	1
Chiasmodontidæ	4	3			7
Zanclidæ					
Zanclus canescens Linn.				3	3
Teuthididæ			4		4
Acronurus larvæ	225	132	6	4	367
Uranoscopidæ	1				1
Labridæ	1				1
Siganidæ		1	1		2
Gempylidæ					
Gempylus serpens C. & V.	3	12	1	2	18
Rexia solandri Cuivier	3	9			12
Trichiuridæ	33	186		90	309
Scombridæ					
Euthynnus yaito Kishinouye		4			4
Auxis	15	97	1	11	124
Tuna-like (juvenile)	16	21		1	38
Xiphasiidæ					
Xiphasia setifer Swainson	1		1	1	3
Tetragonuridæ					
Tetragonurus cuvieri Risso	1				1
Blenniidæ	3				3
Order Scleroparei:					
Platycephalidæ	1		1		2
Dactylopteridæ	14	34	1	4	53
Order Hypostomides:					
Pegasidæ	2				2
Order Plectognathi:					
Triacanthidæ	419	68	2		489
Balistidæ	91	22		5	118
Ostraciontidæ	26	2	1	1	30
Tetraodontidæ	50	19	1	3	73
Diodontidæ	3	2			5
Monacanthidæ	51	37	12	5	105
Pseudaluteres nasicornis (Schlegel)	3				3
Digested Fishes	151	177	50	11	389
Unidentified Juvenile Fishes	66	226	2		294
Invertebrates:					
Phylum Mollusca					
S. O. Pteropoda	23				23
S. O. Decapoda (squids)	224	237			461

TABLE 4.—*List of organisms recovered from the stomachs of tunas and dolphins*—Continued

Name of fish	*N. macropterus*	*K. pelamis*	*E. yaito*	*C. hippurus*	Total
S. O. Octopoda (Argonautidæ) paper nautilus	16	4			20
Phylum Arthropoda					
Order Cirripedia (barnacle)	3				3
Order Amphipoda	32	40			72
Order Stomatopoda	527	257	89	11	884
Order Decapoda					
Zoea larva of crab	201	7			208
Megalopa larva of crab	274	118	200	4	596
Shrimps	96	29			125
Crabs	2	2			4
Phyllosoma larva of spiny lobster (Palinuridæ)	9	23			32
Phylum Chordata:					
Subphylum Tunicata					
Class Thaliacea(Empty Test)	7				7

SUMMARY

The stomachs of 115 yellowfin tunas, 115 skipjacks, 75 oceanic bonitos, and 26 dolphins were examined. These were collected mostly by the research vessel *Spencer F. Baird*, of the Philippine Fishery Program, U. S. Fish and Wildlife Service during the period from September, 1947 to June, 1949.

Fish form the most important item of the diet of these wanderers of the sea. These are either pelagic, demersal, shore, or coral reef fishes. The juveniles of fishes constitute the more common article of the diet. These are best represented by the *Acronurus* larvæ (Teuthididæ).

The otherwise Plectognathic fishes not utilized as food for the table were found to be an important food item of these species and indicate that these wanderers of the sea go near the shore and coral reefs to forage there.

Of the larger fish included in the food items, a few specimens of *Auxis* about 250 mm F.L. were found in the stomachs of yellowfins 674 mm in fork length.

Rare and deep-sea fishes were seen in the stomachs of these species. Some of them were in good condition. Among these are three newly recorded from Philippine waters that will be described later.

Pelagic invertebrates also form an important food item of the tunas. In fact, the larvæ and juveniles of Stomatopoda form the most important single item of food both in numbers of individuals and number of occurrences. Other invertebrates found eaten are squids and juvenile octopuses among the mollusks, and crab larvæ such as zoea and megalopa. Shrimps and young crabs were also recorded.

These pelagic fishes are seemingly nonselective, that is, they are voracious eaters. They would eat any living organism available.

Fifty-one families of fishes, representing 11 orders, were recorded from the stomachs of these pelagic species in Philippine waters.

REFERENCES

GOODE, G. B., and T. H. BEAN.
Oceanic Ichthyology, Mem. Mus. Comp. Zool., Harvard Coll. 22 (1896) 1–553, 153 pls. Special Bull. U. S. Nat. Mus.

JORDAN, D. S., and B. W. EVERMANN.
The Aquatic resources of the Hawaiian Islands. Bull. of the U. S. Fish Commission 23 Parts 1 and 2 (1905).

KISHINOUYE, K.
The food of tunas. Nippon Suisan Gakkai Ho 2 (1) (1917) 106–108, Pac.—Oceanic Fish Inv. Translation No. 29. (1949).

LAGLER, K. F., and C. L. HUBB.
Food of the long-nosed gar (*Lepisosteus osseus oxyurus*) and the bowfin (*Amia calva*) in Southern Michigan. Copeia 4 (1940) 238–241.

LEONARD, J. W.
Feeding habits of trout in waters carrying a heavy population of naturally hatched fry. Copeia 31 (1938).

LUTKEN, C.
Spolia Atlantica. Bidrag til Kundskab om Formforandringer hos fiske under deres vaext og udvikling, saerligt hos nogle af atlanterhavets hafiske. Vidensk. selsk. skr., 5, Raekke, naturvidenskabelig og mathematisk afd. 12 (6) (1880) 413–613.

MURPHY, G. I.
The food of young large mouth black bass (*Micropterus salmoides*) in Clear Lake, California, Calif. Fish and Game Bull. 35 (3) (1949) 159–163.

NAKAMURA, H.
On the food habits of yellowfin tuna *N. macropterus* (Schlegel) from the Celebes Sea. Transaction of the Natural History of Formosa, 26 (1936) Pac. Oceanic Fish. Inv. Translation No. 17. (1949).

PARR, A. E.
Deepsea Fishes of the Order Iniomi from the waters around the Bahama and Bermuda Islands. Bull. Bingham Oceanogr. Coll. 3 Art. 3 (1928).

A Contribution of the Osteology and Classification of the Orders Iniomi and Xenoberyces. Occasional Papers. Bingham Oceanogr. Coll. 2 (1929).

SHAPOLOV, L.
Food of the striped bass. Calif. Fish and Game Bull. 22 (4) (1936) 261–271.

SILLIMAN, R. P.

Fluctuations in the diet of the chinook and silver salmons (*Oncorhynchus tschawytscha* and *O. kisutch*) off Washington, as related to the troll catch of salmon. Copeia 2 (1941) 80–87.

WADE, C. B.

Notes on the Philippine Frigate Mackerels Family Thunnidae, Genus, *Auxis*. U. S. Fish and Wildlife Service Fishery Bull. 46 (1949) 229–240.

Juvenile forms of *Neothunnus macropterus, Katsuwonus pelamis* and *Euthynnus yaito* from the Philippine Seas. U. S. Fish and Wildlife Service Bull. 53 (1950) 395–404.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Percentages of food items of Philippine tunas and dolphins determined on the basis of numbers formed in the stomachs.

2. Percentages of identified fish food items recovered from stomachs of Philippine tunas and dolphins.

STUDIES ON THE SALT CONCENTRATION OF COMMERCIALLY DRIED (TUYO) AND SMOKED (TINAPA) HERRING

By V. Uyenco, P. Rodriguez, and R. Taruc
of the Bureau of Fisheries, Manila

ONE TEXT FIGURE

INTRODUCTION

The Philippine fish production for 1949 was estimated at some 238,000,000 kilograms of fish. Ten per cent of this, or 23,800,000 kilograms, were processed and the rest sold fresh or iced. Of the processed fish, 70 per cent were dried and smoked, and the 30 per cent were manufactured into fermented products like fish paste (*bagoong*) and fish sauce (*patis*). The herrings form the bulk of our processed fish products as shown by the following data:

DRIED, SMOKED AND SALTED FISH

	Per cent
Herring and allied species	52
Tuna, mackerel, and allied species	14
Jacks, pampanos, and allied species	6
Barracudas, mullets, and allied species	5
Mollusks (oysters, mussels, clams, scallops, cuttle fish, etc.	5
Crustaceans	4
Milkfish	2
Perches, croakers, breams, basses, and allied species	2
Teleostean fresh water species	1
Other Teleostean marine species	9
	100

Three species of herrings, *tunsoy* (*Sardinella fimbriata*), *lapad* (*S. perforata*), and *tamban* (*S. longiceps*), constitute 25 per cent of the total fish processed as dried and smoked. The first two species are made into *tuyo* or *tinapa* and the third one into *tinapa*. Tuyo (literally means dried) is the trade name for dried herrings, tinapa for the smoked. Tuyo is brine-salted in the round, and subsequently dried under the sun. In the preparation of tinapa the fish are dipped in boiling dilute brine for a few minutes and then subsequently smoked. These processed herrings bring in the sum of

3,600,000 pesos when sold in the retail market at an average cost of 60 centavos per kilo (1949). Martin(1) describes in detail the making of tinapa and Montalban(2) and Seale(3) discuss the preparation of tuyo in their papers published in the Philippine Journal of Science.

A survey of the tuyo found in the market reveals that it is too salty, so portions of the product served on the table are discarded as scraps. There is so much waste of fish and salt and the finished product is generally of poor quality. The dried fish are usually "burnt" and too blanched because of over-salting. The fish are not usually fresh at the time they are processed for they are caught too far away from the processing plants. This is particularly true with fish delivered in Manila, whereas dried fish coming from localities near the fishing grounds, especially in the Visayas are of better quality. The erroneous practice of over-salting to improve stale or slightly tainted fish cannot be over-emphasized.

We believe that there are other shortcomings which should be overcome, but for the present we are limiting our study to salt concentration of tuyo and tinapa.

EXPERIMENTAL METHOD

The tuyo and tinapa were bought from wholesalers in the city markets from September 1949 to July 1950. Lots of 25 to 50 pieces of fish were picked from the wholesaler's basket with the idea that such a number coming from a basket of 100 fish would constitute a homogeneous group that were processed together.

A panel of tasters was organized from the personnel of the Bureau of Fisheries. The usual consideration in organizing a panel was observed. Each lot of fish was divided into two portions, one for panel test and the other for analysis. For panel tasting, the fish were cooked the usual native way of serving tuyo and tinapa. The panel judged them into five degrees of saltiness.

The portions for analysis were scaled and only the edible flesh was taken and finely chopped to get a homogeneous sample of each lot. Moisture determination was done by using a vacuum oven maintained at 100°C. and evacuated to 25 lbs. reading in the vacuum gauge. Sodium chloride analysis was performed on the fresh and dried samples, using the "Open Carius Method" of the A.O.A.C. (1945 ed., par.

24.5). The results of the analysis were made to tally with the judgment of the panel.

RESULTS AND DISCUSSION

According to the panel test (Table 1), all samples of tuyo excepting one (DL–6) were over-salted while most of the tinapa had the right saltiness, 5 to 7 per cent fresh basis, or 12 to 18 per cent dry basis. For tuyo, only one sample came within the "just-right" grouping, and gave an analysis of 9.22 per cent fresh basis, so that a range for the right concentration of salt for tuyo could not be established. Because of this, we did our own salting to establish the desired range and also to determine the length of time of immersion using saturated brine that will give the desired salt concentration.

TABLE 1.—*Moisture and sodium chloride analysis of dried (tuyo) and smoked herring (tinapa).*

[D–Dried (tuyo); S–smoked (Tinapa); L–lapad; T–tunsoy. Example: DL–8 means dried 'lapad' lot 8; ST–9 means smoked 'tunsoy lot 9].

Panel test		Moisture		Sodium chloride			
Rating		Tuyo	Tinapa	Tuyo		Tinapa	
				Fresh	H_2O free	Fresh	H_2O free
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Very salty	D –1	43.62		14.50	25.75		
	DT–7	47.70		12.72	24.41		
	DL–8	43.42		12.61	21.80		
	DT–9	47.56		12.02	22.14		
In between "very salty" and salty	DL–4	46.40		14.69	27.14		
	D –2	43.57		13.72	24.35		
	DL–5	39.89		13.24	22.37		
	DT 4	41.46		12.06	20.55		
Salty	DT 5	45.50		12.21	22.48		
	DL–3	41.48		11.70	20.43		
	S –2		52.69			10.40	22.01
In between salty and just right	DT–8	41.77		11.87	20.51		
	DL–7	41.88		11.27	19.36		
	DT–6	47.04		7.78	14.72		
	SL –8		59.93			10.50	26.55
	S –1		51.64			9.40	19.49
	SL –3		57.21			9.36	21.87
Just right	DL–6	44.24		9.22	16.54		
	SL 4		55.30			7.31	16.35
	ST –8		63.81			6.93	18.81
	SL –7		57.16			6.69	15.62
	SL –6		64.64			6.48	18.36
	ST –5		59.30			6.41	15.74
	SL 5		60.16			6.00	15.10
	ST–7		67.59			5.14	15.87
	ST –4		58.75			5.00	12.12
Flat							

The fish we salted were about of the same size as the ones bought from the market. Saturated brine of Parañaque salt at room temperature was used throughout this work. This is the salt most processors use.

From Table 2 the "just-right" range for sodium chloride is from 8 to 10 per cent fresh basis, 11 to 14 per cent moisture-free basis. These samples falling under the "just-right" group, as judged by the panel, were immersed from 20 to 40 minutes. No wonder, most tuyo sold in the market are too salty, for the commercial practice is by immersion lasting from 3 to 5 hours and sometimes overnight. After an hour of immersion the fish have practically taken in the maximum amount of salt (see characteristic curves of salt absorption with respect to time; note the levelling off, after 60 minutes, fig. 1). The processors have no regard for the proper salt

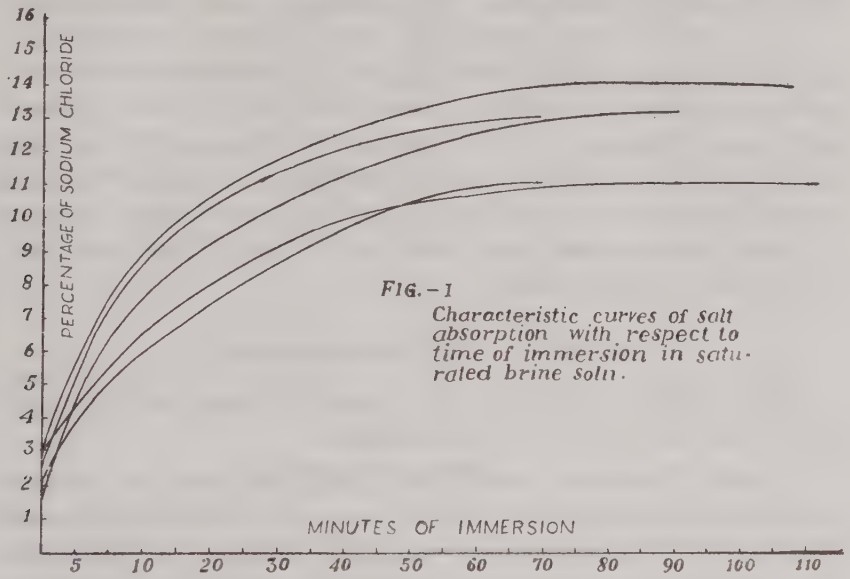


FIG. – 1
Characteristic curves of salt absorption with respect to time of immersion in saturated brine soln.

concentration. They substitute immersion in brine for cold storage to preserve their stock of fish and because the fish are tainted most often, they intentionally oversalt them. Oversalting does not improve the quality of processed fish nor can it restore freshness to stale fish. The quality of a processed fish can only be as good as at the time it was processed. Drying is the better way of preserving compared to salting. (Take note from Tables 1 and 2, "just-right" grouping that on the basis of salt per weight of tissue (H_2O–free basis tinapa has more salt than tuyo and yet tinapa keeps for a very much shorter time than tuyo.) Salting alone without the accompanying reduction in moisture content of fish does not prevent chemical changes. A good example of this is "bagoong" and "patis" processing.

The question is often asked. What is the best moisture content for tuyo or, for that matter, all dried fish under local conditions? Our observations and experience on the processing of dried fish place it between 25 to 30 per cent moisture during dry season (December–April) and 30 to 35 per cent during wet season. The drier the product the better it keeps, however, due to the high humidity in the atmosphere, moisture content lower than the ranges given above is not practicable, and even granting that a product is dried lower than 30 per cent moisture, it will reabsorb some moisture from the air on standing. The equilibrium-moisture-content of our salted fish is around 35 per cent moisture, which means that our salted fish containing 35 per cent moisture and stored under our local atmospheric conditions will neither absorb nor give up moisture. In other words, it is in equilibrium with water vapor of our air. Table 2 presents a column "NaCl of Sample Adjusted to 35 per cent H_2O," because we think drying to 35 per cent moisture is the most logical for our local condition of relatively high humidity.

CONCLUSIONS AND RECOMMENDATIONS

1. Our commercial fish product, tuyo, is oversalted while our tinapa has the right salt concentration.

2. A good tuyo will have a range of 8–10 per cent sodium chloride fresh basis with moisture content of 25 to 30 per cent. This desirable salt concentration can be attained by immersion in saturated brine at room temperature from 30 to 40 minutes. These conditions will hold good for our ordinary sizes of herrings.

3. Salt concentration greater than what is recommended will not lengthen keeping time for the slight increase of salt over the desirable range will not make the products keep longer. It is the amount of moisture in the tissue which determines the keeping time.

4. If processors will cut their brining time to 30–40 minutes, they will be saving some 250,000 pesos worth of fish alone, not counting the loss in extra materials and time, and also the increase in price rightly salted tuyo will command.

TABLE 2.—*Dried herring (tuyo)*

[Numbers before letter B stands for minutes of immersion; those after letter B stands for batch number. Thus 50 B–10 means sample of batch 10 immersed for 50 minutes]

Panel rating	Sample No.	Moisture	Sodium chloride		NaCl of sample adjusted to 35% H_2O
			Fresh basis	Moisture free	
		Per cent	*Per cent*	*Per cent*	*Per cent*
	70 B–12	24.95	16.37	22.51	14.62
	55 B–12	23.12	14.81	19.23	12.50
	90 B–12	23.62	13.57	17.87	11.62
	55 B–11	21.18	13.27	16.97	11.03
1. Very Salty	60 B–12	22.90	12.72	16.07	10.45
	60 B–11	21.47	12.71	16.39	10.66
	80 B–12	26.55	12.60	17.02	11.07
	50 B–10	29.38	11.31	15.88	10.32
	55 B–10	28.78	10.88	15.27	9.93
	60 B–10	30.69	10.72	15.54	10.10
	60 B–12	24.46	10.34	13.44	8.73
	40 B–11	23.87	12.21	16.15	10.50
2. Salty	45 B–11	21.13	11.77	15.03	9.77
	50 B–11	22.72	11.50	14.58	9.48
	45 B–12	26.02	10.83	14.62	9.48
	20 B–11	22.25	10.53	14.03	9.12
	40 B–12	27.58	9.80	13.76	8.95
	30 B–11	22.44	9.80	12.79	8.31
3. Just right	30 B–12	28.29	9.61	13.83	8.99
	45 B–10	29.15	8.61	12.50	8.13
	30 B–10	28.63	8.43	12.21	7.93
	40 B–10	28.70	8.13	10.68	6.94
	20 B–12	30.28	8.13	11.49	7.47
	10 B–11	22 31	8.40	10.99	7.15
4. Less than just right	10 B–12	29.85	7.12	10.18	6.62
	20 B–10	27.49	6.49	8.93	5.81
	10 B–10	25.16	5.81	7.63	4.96
	0 B–10	21 32	2.64	3.07	2.00
5. Very flat	0 B–11	16.63	2.26	2.69	1.75
	0 B–12	24.35	1.61	2.09	1.36

REFERENCES CITED

SEALES, ALVIN.

Preservation of commercial fish and fishery products in the tropics. Phil. Jour. Sci. 9 (1914).

MONTALBAN, HERACLIO R.

Investigation on fish preservation conducted at Estancia, Panay, Philippine Islands. Phil. Jour. Sci. 42 (1930) 309–335.

MARTIN, CLARO.

Methods of smoking fish around Manila Bay. Phil. Jour. Sci. 55 (1934) 79–89.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Characteristic curves of salt absorption with respect to time of immersion in saturated brine solution.

THE EFFECT OF SALT, VINEGAR, AND HEAT ON THE COLIFORMS IN OYSTERS

By ENRIQUE S. SALAFRANCA
Of the Bureau of Fisheries, Manila

FOUR TEXT FIGURES

Oysters obtained from the areas adjoining the City of Manila have been shown to be invariably polluted (Clague, 1950: Division of Public Health Laboratory, 1952; Salafranca, 1952). Corrective measures have, accordingly, been recommended. Realizing the danger posed by these polluted oysters to the health of the people partaking of them, the Secretary of the Department of Health created in 1951, the Committee on Shellfish Industry. The main function of this body is to make experimental studies on the development of an efficient and practical method of purifying oysters. The plans laid out for this purpose have not been put to trial owing to certain difficulties. In the meantime, the experiments reported in this paper were conducted to determine to what extent the common practices observed in preparing oysters for the table affect their bacterial contents, particularly the coliforms.

The effects of salt and vinegar, which are the most common ingredients used, and heat were investigated. These were determined by periodic checks on the total bacterial counts, (TBC) and coliform counts (CC) of the oyster samples.

MATERIALS AND METHODS

The oysters used in these experiments were obtained from the Binakayan oyster farm of the Bureau of Fisheries. The oysters were thoroughly cleaned and shucked asceptically as described in a previous work (Salafranca, 1952).

Salt.—Two series of experiments using salt were conducted. In one series, granulated rock salt with 99.45 per cent sodium chloride (moisture content, 0.006 per cent) was used, and in the other, granulated solar salt with 82 per cent sodium chloride (moisture content, 9.9 per cent). Salt concentrations of 10, 15, 20, and 25 per cent (W/W) were tried at room temperature (RT)[1], 37° C., and 45° C. For seasoning, a 10 per cent salt concentration is high even for people who like their food salty

[1] Room temperature ranged from 23.5° to 27°C. at about 8:00 A.M. and from 27° to 30°C. at about 3:00 P.M. during the period of these experiments.

However, our initial trials with 10 per cent salt showed that even with this amount of salt the oysters spoiled before they were rid of their coliform contents, hence, higher concentrations were tried.

Vinegar.—Vinegar with an acetic acid content of 3.47 per cent was used. Concentrations of 10, 15, 20, 25, and 30 per cent (W/W) at RT, 37° C, and 45° C were tried. Observations similar to those made in the trials with salt determined our choice of concentrations higher than 10 per cent.

Heat.—The effect of various low degrees of heat, including RT, 37° C., 45° C., 59°–61° C. and 99°–101° C. (boiling) were tried. Experiments were conducted at RT, 37°C., and 45°C. out of curiosity inasmuch as these degrees of heat do not approximate any of the heat treatments to which oysters intended to be served fresh are subjected. An electrically heated water bath whose temperature oscillated between 61°–65° C. was employed to heat oyster specimens inside beakers to between 59°–61° C. This water bath treatment gave us the nearest approach possible with our facilities to the temperature to which the oyster meat is subjected when the oyster is steamed to open the shell and is served in this manner. A temperature of 99°–101° C. in the center of the mass was obtained by boiling over an open flame. This was employed to approximate the heat to which oysters are subjected when they are blanched prior to serving.

Culture media.—ZoBell's (1946) 2216 plating medium was employed for determining the TBC.

Lactose broth, EMB agar, Dunham's peptone broth, Clark and Lub's medium, and Koser citrate broth were used for the various cultural tests for coliforms.

In each trial performed in the course of these experiments, no less than 100 grams of oyster meat with the corresponding nectar were used. The TBC and CC of the fresh, untreated material were determined to obtain the initial counts which served as the basis of comparison for the subsequent counts of the corresponding treated portions of the specimens.

A sample of at least 10 grams was employed for each check on the TBC and CC of the treated material. An amount of sterile aged sea water sufficient to make a 10 per cent emulsion was added and the whole run through a Waring blendor for about 30 seconds. The coarse particles were allowed to settle and the emulsified sample was used for the various bacteriological cultures.

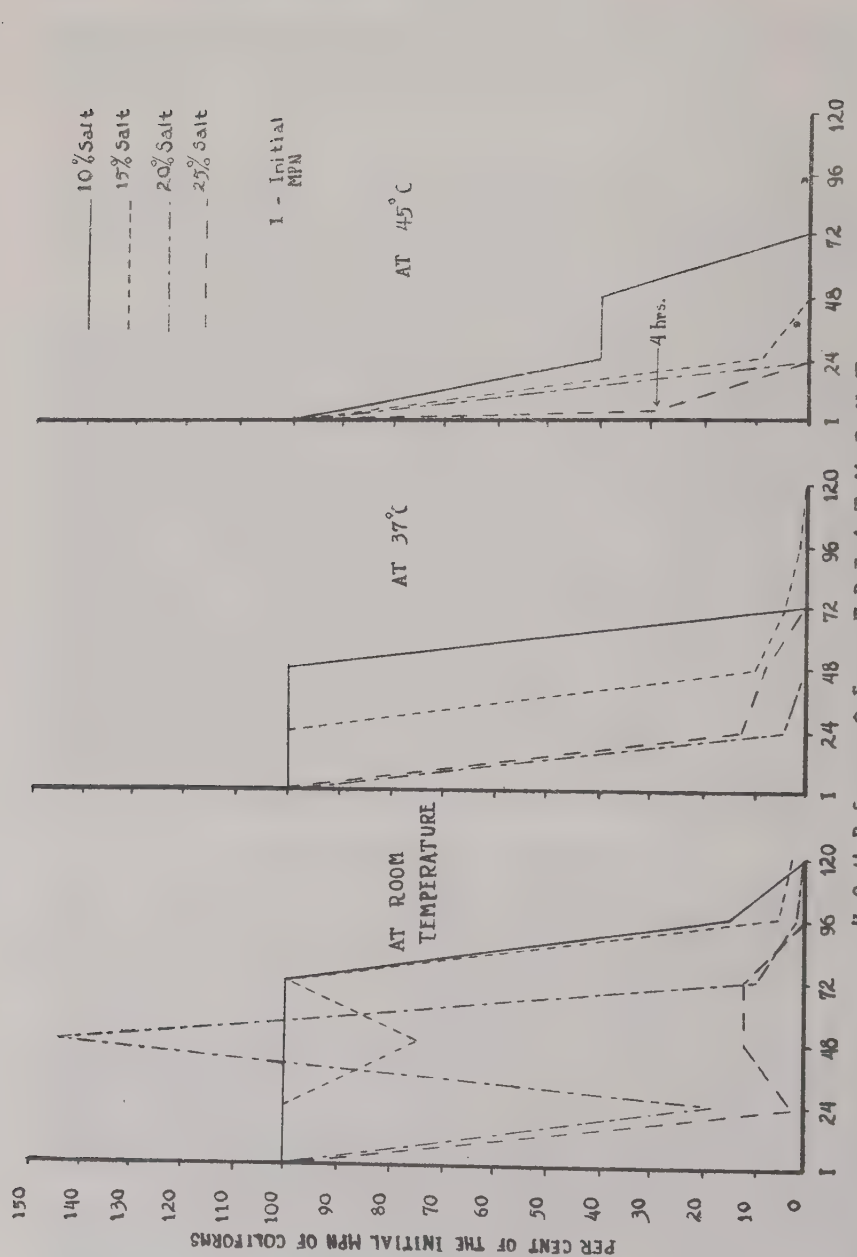


FIG. 1. Trends in the MPN of coliforms in oysters treated with granulated rock (99.45 per cent)

The procedures and techniques adopted for enumeration and computation of the TBC from the plate cultures, the coliform presumptive and confirmatory tests, and the determination of the most probable number (MPN) of coliforms were exactly those described in a previous work in connection with the bacteriological (survey of oysters at the Binakayan oyster farm (Salafranca, 1952).

The initial counts of the fresh oysters were assigned a value of 100 per cent. The bacterial counts obtained in the periodic checks were expressed as percentages of the corresponding initial counts. The counts thus expressed are easily comparable.

RESULTS AND DISCUSSIONS

1. Granulated rock salt (99.45 per cent NaCl and 0.006 per cent moisture).—The results obtained in the trials using this quality of salt are summarized in Table 1. The initial counts have been omitted. The counts in the periodic checks of the treated samples, as stated above, are expressed as percentages of the corresponding initial counts.

Oyster specimens treated with 10, 15, and 20 per cent salt in many instances, reached much greater TBC levels than the corresponding initial counts; with 25 per cent, the TBC were much lower. With a given salt concentration, the counts were generally higher at RT and 37° C. than those at 45° C.

The CC obtained in this series with one exception, were never higher than the corresponding initial counts (fig. 1).

Oysters with 10 and 20 per cent salt concentrations, at RT, were rid of coliforms in about 120 hours; with 15 per cent, the oysters spoiled before a negative CC could be obtained; and with 25 per cent the oysters were rid of coliforms in about 96 hours. At 37° C., 10, 20, and 25 per cent salt concentrations required about 72 hours and 15 per cent about 120 hours to destroy the coliforms. At 45° C., the time required to destroy the coliforms shortened with the increase in salt concentrations: about 72 hours for 10 per cent, 48 hours for 15 per cent, and about 24 hours each for 20 and 25 per cent (fig. 3).

2. Malabon solar salt (82 per cent NaCl and 9.9 per cent moisture).—In general, higher counts were obtained in specimens with lower salt concentrations than those obtained in specimens with higher salt concentrations and lower germicidal power was demonstrated with 15 per cent salt than that demonstrated with 10 per cent salt of this quality (Table 2 and fig. 2).

TEXT FIGURES

TABLE 1.—*Effect of granulated rock salt (99.45 per cent NaCl with 0.006 per cent moisture) on the total bacterial and coliform counts of oysters.*

Treatment	Bacterial counts												Remarks
	4 hours[a]		24 hours		48 hours		72 hours		96 hours		120 hours		
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
10 per cent at R. T.	------	------	[b]1,455	100	24,442	100	27,302	100	45,913	15	52,263	0	One trial, Developed off—odors after 48 hours.
10 per cent at 37° C	------	------	19,830	100	42,797	100	18,816	0	21,574	0	7,346	0	One trial. Developed off—odors after 48 hours.
10 per cent at 45° C	------	------	358	40	137	40	14,202	0	2	0	0.25	0	One trial. Developed off—odors after 48 hours.
15 per cent at R. T.	------	------	10	100	7	75	16	100	52	5	68	3	One trial.
15 per cent at 37° C	------	------	24,883	100	340	10	2,280	5	2,391	1	2,426	0	One trial.
15 per cent at 45° C	------	------	32	10	48	0	80	0	689	0	------	------	One trial.
20 per cent at R. T.	------	------	10	19	19	144	1,112	10	633	1	1,887	0	Average of 4 trials.
20 per cent at 37° C	------	------	355	6	102	0.1	39	0	60	0	------	------	Average of 5 trials.
20 per cent at 45° C	------	------	5	0	76	0	138	0	------	------	------	------	Average of 3 trials.
25 per cent at R. T.	------	------	2	3	3	12	4	12	0.5	0	0.1	0	Average of 2 trials.
25 per cent at 37° C	------	------	1	13	2	9	1	0	1	0	------	------	Average of 2 trials.
25 per cent at 45° C	2	29	1	0	1	0	1	0	1	0	0 0.4	0	Average of 2 trials.

[a] Number of hours of treatment and storage at temperatures indicated.

[b] All figures represent per cent of the "TBC" and "CC" of the corresponding fresh, untreated oyster specimens. TBC—Total bacteriai counts; CC—coliform counts.

TABLE 2.—*The effect of Malabon solar salt (82 per cent NaCl with 9.9 per cent moisture) on the total bacterial and coliform counts of oysters.*

Treatment	Bacterial counts												Remarks
	4 hours[a]		24 hours		48 hours		72 hours		96 hours		120 hours		
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
10 per cent at R. T.	[b]142	75	595	109	26,900	24.7	114,000	8.43	----------	------	-------	------	One trial. Putrid after 96 hours.
10 per cent at 37° C	10.2	15.3	655	20	825	24.6	28,867	40	----------	------	-------	------	One trial. Putrid after 96 hours.
10 per cent at 45° C	7	109.3	54	0	539	0	4,286	0	----------	------	-------	------	One trial.
15 per cent at R. T.	293.26	76.88	1,069.41	8.11	6,583.14	4.78	37,548.15	22.95	6.52M	0	2.15M	0	Average of 3 trials.
15 per cent at 37° C	353.11	82.74	339.5	6.3	194,868.88	49.57	20,055.21	0.61	190.5	0	-------	------	Average of 3 trials.
15 per cent at 45° C	772.96	39.33	1,792.76	6.8	10,681.77	0	30,572.49	0	190	0	-------	------	Average of 3 trials.
20 per cent at R. T.	11.36	68.73	14.54	7.7	21.81	16.25	10.9	0	2,909.09	0	-------	------	One trial.
20 per cent at 37° C	21.81	0	18.18	0	81.81	0	1,563.63	0	5,481.81	0	-------	------	One trial.
20 per cent at 45° C	15.41	1.6	7.56	0	12.35	0	973.59	0	0.59	0	-------	------	Average of 2 trials.
25 per cent at R. T.	22.30	7.6	2.69	11.41	103.84	0	7.16	0	1.30	0	-------	------	One trial.
25 per cent at 37° C	11.53	22.28	10.38	21.73	22.3	0	0.53	0	0.71	0	-------	------	One trial.
25 per cent at 45° C	3.84	9.23	2.3	0	7.11	0	0.67	0	----------	------	-------	------	One trial.

[a] Number of hours of treatment and storage at temperatures indicated.

[b] All figures represent per cent of the "TBC" and "CC" of the corresponding fresh, untreated oysters specimens. TBC—Total bacterial counts; CC—coliform counts; M—million.

At RT and 37° C., it was not possible to determine the approximate period 10 per cent salt concentration would require to destroy the coliforms inasmuch as the oysters were putrid after 96 hours and were discarded. At 45° C. about 24 hours were required to destroy the coliforms. Oysters with 15 per cent salt stored at RT and 37° C., respectively, required about 96 hours; at 45°C., about 48 hours. With 20 per cent salt the results were irregular: at RT, about 72 hours; at 37° C., about 4 hours; and at 45° C., about 24 hours. While no attempt was made to determine the cause of this irregularity, several possibilities were noted: variation in the size and nutritive condition of the individual oyster and possible variation in the number and species of their coliform content. Oysters with 25 per cent salt and stored at RT and 37° C., respectively, were negative for coliforms after about 48 hours; at 45° C., after about 24 hours.

In general, the observations in connection with the germicidal power of salt confirm those made by other investigators who have worked along similar aspects of this problem. Salle (1948) states that low concentrations of salt tend to stimulate bacterial growth, whereas, higher concentrations are toxic. Baumgartner (1946) states that the effect of salt on the resistance of microorganisms to heat varies with the concentration employed. Viltjoen, as cited by Baumgartner (1946), found that amounts up to 4 per cent protected the spores of several microorganisms heated in canned pea liquor. Sherman and Holm, as cited by Salle (1948), found that low concentrations of NaCl produced accelerating effect on the growth of *Escherichia coli*. They found that 0.02 M (about 1.16 per cent)[2] to be optimum. A period of equilibrium between the death rate and the rate of multiplication of coliforms is evident in the trials at RT and 37°C. with 10 per cent rock salt (fig. 1) and a period of mild stimulation in the trials at RT and 45°C. with 10 per cent solar salt (fig. 2). This period is about 72 hours and about 4–24 hours, respectively. The presence of great amounts of organic matter in the specimens treated has apparently inactivated the greater portion of the initial amounts of the salt dissolved. Salle (1948) states that salts are more germicidal in distilled water than in solutions containing protein; the organic matter greatly inactivating the salt. It takes sometime, therefore, before the coliforms are exposed to the

[2] Figure in parenthesis is based on our computation.

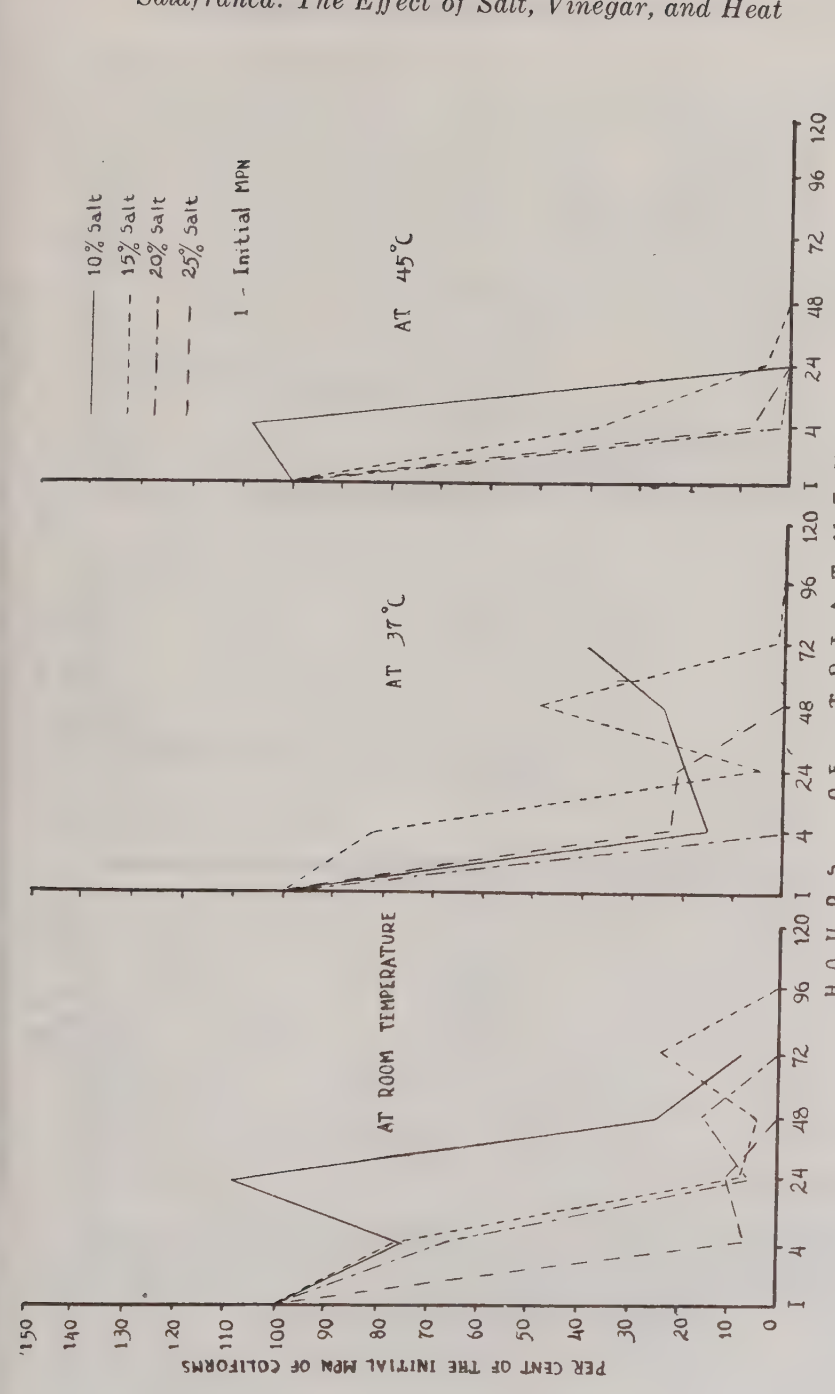


FIG. 2. Trends in the MPN of coliforms in oysters treated with solar salt (82 per cent NaCl)

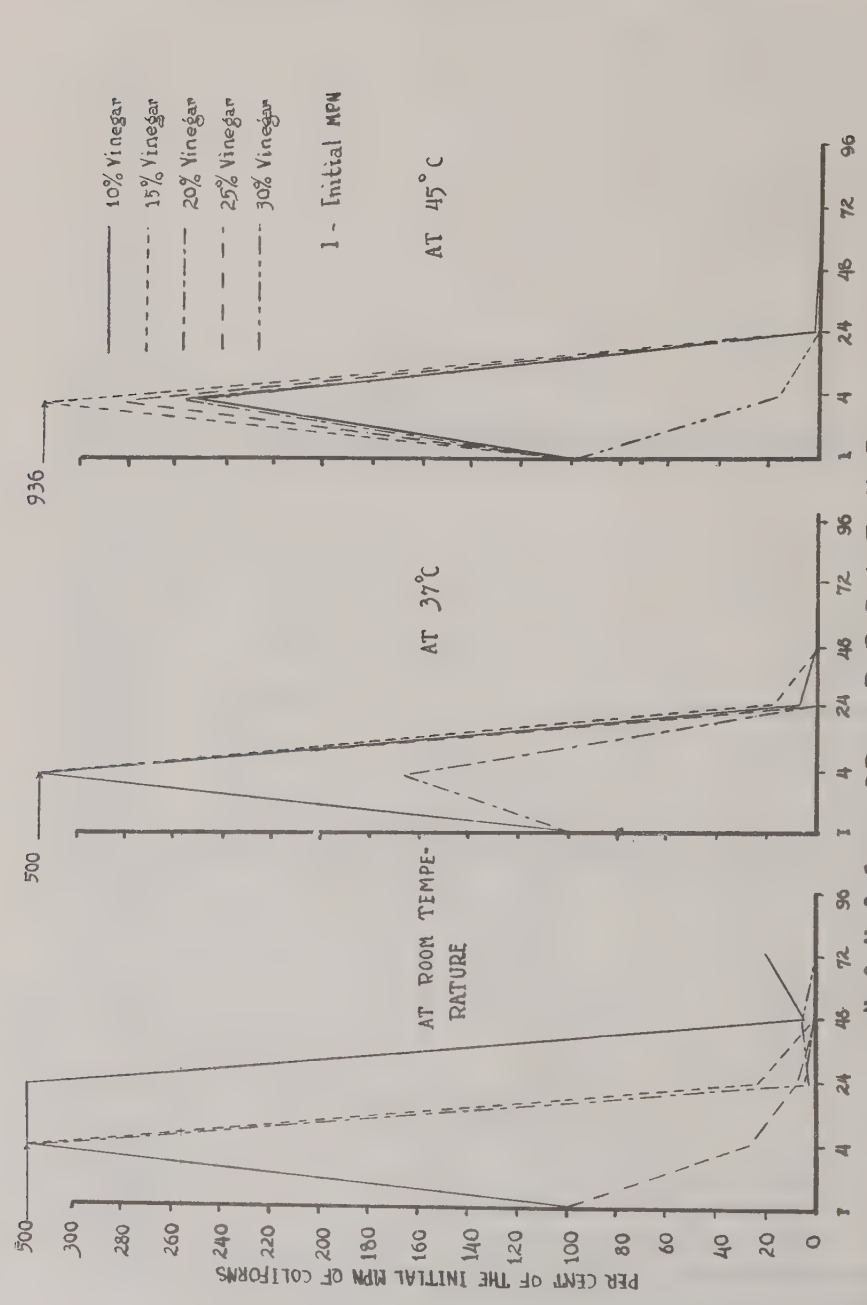


Fig. 3. Trends in the MPN of coliforms in oysters treated with vinegar (acetic acid 3.47 per cent)

full concentration attainable from the amount of salt added. In the meantime, the low concentration stimulates the growth of the coliforms resulting in the periods of stimulation or at least the state of equilibrium noted.

Rock salt, when added in amounts to make a final concentration of 10 per cent, required about 18 hours to dissolve completely; solar salt about, 4 hours. This, probably, accounts for the longer periods of equilibrium observed in specimens treated with rock salt than the periods of stimulation observed in specimens treated with solar salt.

3. Vinegar (acetic acid content 3.47 per cent).—The results indicate (Table 3) that this quality of vinegar in the concentrations employed, is a more powerful bactericide than either of the two qualities of salt used, in the concentrations they were employed (Tables 1 and 2).

An initial stimulation of the growth of the coliforms occurred during the first 4 hours, or thereabouts, in all but two trials. In about 24 hours, however, a marked reduction in the CC was evident in all but one trial (fig. 3). The possible explanation for the variations have already been pointed out previously: differences in the size and nutritive condition of the oysters, and in the number and species of their coliform content. After 48 hours, the specimens in all but two trials showed a negative CC.

The results indicate that raising the temperature enhances the germicidal power of any of the vinegar concentrations tried. Oyster specimens with 10 per cent vinegar, after 48 hours at RT, were moldy and no further checks were made; at 37° C. and at 45° C., the specimens were rid of coliforms in about 48 hours. Specimens with 15 and 25 per cent at RT and 37° C., were free of coliforms after 48 hours; at 45° C., after about 24 hours. Those with 20 per cent at RT, 37° C., and 45° C., in about 48, 24, and 48 hours, respectively; with 30 per cent, in about 72, 24, and 24 hours, respectively.

Winslow and Lochridge, as cited by Salle (1948), showed that a 0.0812 N (approximately 0.49 per cent)[3] solution of acetic acid was required to produce a 99 per cent reduction in the number of *E. coli* after an exposure of 10 minutes. These experiments, however, were conducted using laboratory media. According to Baumgartner (1946), for commercial purposes, higher concentrations of about 1.5 to 2 per cent are required. In our trials with vinegar, the concentrations of 10, 15, 20,

[3] Figure in parenthesis is based on our computations.

TABLE 3.—*The effect of vinegar (acetic acid 3.47 per cent) on the total bacterial and coliform counts of oysters*

Treatment	Bacterial counts												Remarks
	4 hours[a]		24 hours		48 hours		72 hours		96 hours		120 hours		
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
10 per cent at R. T.	10.3	500	16.8	500	16.8	6.8	127	20					One trial. Moldy after 72 hours.
10 per cent at 37° C	30.3	500	16.3	9	9.5	0	17.3	0					One trial. Moldy after 72 hours.
10 per cent at 45° C	2	250	3.7	1.2	1.6	0	1.3	0	0.07	0			Average of 2 trials. Markedly hydrolyzed after 72 hours.
15 per cent at R. T.	4.8	500	2.5	25.3	1.08	0	0.1	0	0.8	0			One trial. Markedly hydrolyzed after 72 hours.
15 per cent at 37° C	7.5	500	6.8	15	0.2	0	0.7	0	1.1	0			One trial. Hydrolyzed markedly after 72 hours.
15 per cent at 45° C	1.6	936	3.4	0	0.77	0	0.25	0	0.13	0			Average of 2 trials. Completely hydrolyzed.
20 per cent at R. T.	18	287.5	.67	1.1	2	0	10.33	0	4	0			One trial. Oysters hydrolyzed.
20 per cent at 37° C	16.7	168.7	.67	0	7.3	0	11.3	0	7.7	0			One trial. Oysters hydrolyzed.
20 per cent at 45° C	10.7	257.5	11.7	1.7	3.3	0	4.3	0	1.8	0			Average of 2 trials. Markedly hydrolyzed.
25 per cent at R. T.	2.8	28.7	1.35	3.4	0.5	0	6.5	0					One trial. Moldy. Hydrolyzed.
25 per cent at 37° C	1.6	500	3.2	5.3	6.2	0	1.1	0	0.2	0			One trial. Moldy. Hydrolyzed.
25 per cent at 45° C	39.2	284.3	21.1	0	4.58	0	1.1	0	0.25	0			Average of two trials. Completely hydrolyzed.
30 per cent at R. T.	77.7	500	8	.56	25	7.5	2	0	5.7	0			One trial. Digestion eivdent after 24 hours.
30 per cent at 37° C	34.2	500	5.14	0	13	0	.9	0	5.7	0			One trial. Digestion evident after 24 hours.
30 per cent at 45° C	4.2	10	3.87	0	5.3	0	13.33	0	0.3	0			Average of two trials. Digestion more marked than at R. T. and 37 ° C.

[a] Number of hours of treatment and storage at temperatures indicated.

[b] All figures represent per cent of the original "TBC" and "C" of the corresponding fresh, untreated oyster specimens. TBC—Total bacterial counts; CC—coliform counts.

25, and 30 per cent correspond to approximately 0.35, 0.52, 0.69, 0.86, and 1.04 per cent acetic acid, respectively. Considering the dense mass of the oyster meat, the concentrations tried were really much lower than those suggested by Baumgartner.

4. Heat.—Table 4 summarizes the results of the trials with heat. An initial period of stimulation for the multiplication of coliforms is evident in all of the specimens kept at the various temperatures tried, the period varying with the temperature of exposure. The higher the temperature, the shorter was the period and less marked the stimulation: at RT and 37° C., over 24 hours; at 45° C., about 24 hours; at 59°–61° C., about 5 minutes; and at 99° 101°C., about ½ minute (fig. 4).

The length of time that the coliforms remained alive in oysters kept at RT and at 37° C. has not been determined. The specimens were markedly decomposed after 48 hours and no further checks were made. At 45°C., oyster specimens were negative for coliforms after about 48 hours; at 59°–61° C., after about 1 hour. At 99°–101° C., the specimens were generally negative after about 1 minute. In one of the trials, however, not all the coliforms were destroyed after 10 minutes at 99°–101° C. The possible explanations for this irregularity have already been enumerated elsewhere in this paper.

In contradistinction to the observations made on the CC, an initial decline in the TBC was observed. At RT, 37° C., and 45° C. this decline was followed by a considerable increase in subsequent checks; at 59°–61° C. and at 99°–101° C. the decrement in the TBC was more or less progressive.

This behaviour of the TBC may be explained by the predominance of marine species of microorganisms in the specimens used. The optimum temperature for the growth of these forms is rather low: few of them will grow at temperatures higher than 25° C. (ZoBell, 1946). At RT, 37° C., and 45° C. a great number of them were inhibited or destroyed resulting in the initial decline in the TBC. In the meantime, reproduction of the soil, air, and other contaminants which were also present in the specimens was stimulated. As a result, a marked increase in the TBC is subsequently noted. At 59°–61° C. and at 99°–101° C., the marine forms, as well as most of the contaminants, were destroyed so that at these temperatures a more or less progressive decline in the TBC is noted.

Wilson and Miles (1946) stated that most members of the coliform and *Salmonella* group are killed by exposure to temperatures of 55° C. for about an hour or of 60° C. for 15–20

TABLE 4.—*The effect of heat on the total bacterial and coliform counts of oysters.*

Degree of heat applied	Bacterial counts										Remarks
	4 hours[a]		24 hours		48 hours		72 hours		96 hours		
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
R. T.	[b]39.37	500	54,842	500							One trial each only. Markedly decomposed.
37° C	48.12	500	13,093	500							Bloated after 48 hours.
45° C	18.75	500	11,703	56.25	10,312.5	0	11,250	0	30,625	0	Fermented after 20 hours. One trial.
Water bath	5 minutes[a]		15 minutes		30 minutes		45 minutes		1 hour		Average of 7 trials.
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
59° C–61 C	29.4	326.8	6.09	71.42	1.8	49.5	5.6	62.5	8.5	0	
Direct heat boiling	½ minute[a]		1 minute		5 minutes		10 minutes		15 minutes		Average of 4 trials.
	TBC	CC	TBC	CC	TBC	CC	TBC	CC	TBC	CC	
99° C–101° C	3.01	287	4.49	0	0.753	0	7.41	0	1 054	0	

[a] Number of minutes or hours exposure to degrees of heat indicated.

[b] All figures represent per cent of the original "TBC" and "CC" of the correspondi , fresh untreated oyster specimens. TBC—Total bacterial counts; CC—coliform counts.

minutes; that the various species comprising the coliform group do not differ significantly from one another, although *E. coli* tends to have a slightly higher resistance. It may be presumed, therefore, that when the check on a heat-treated specimen in-

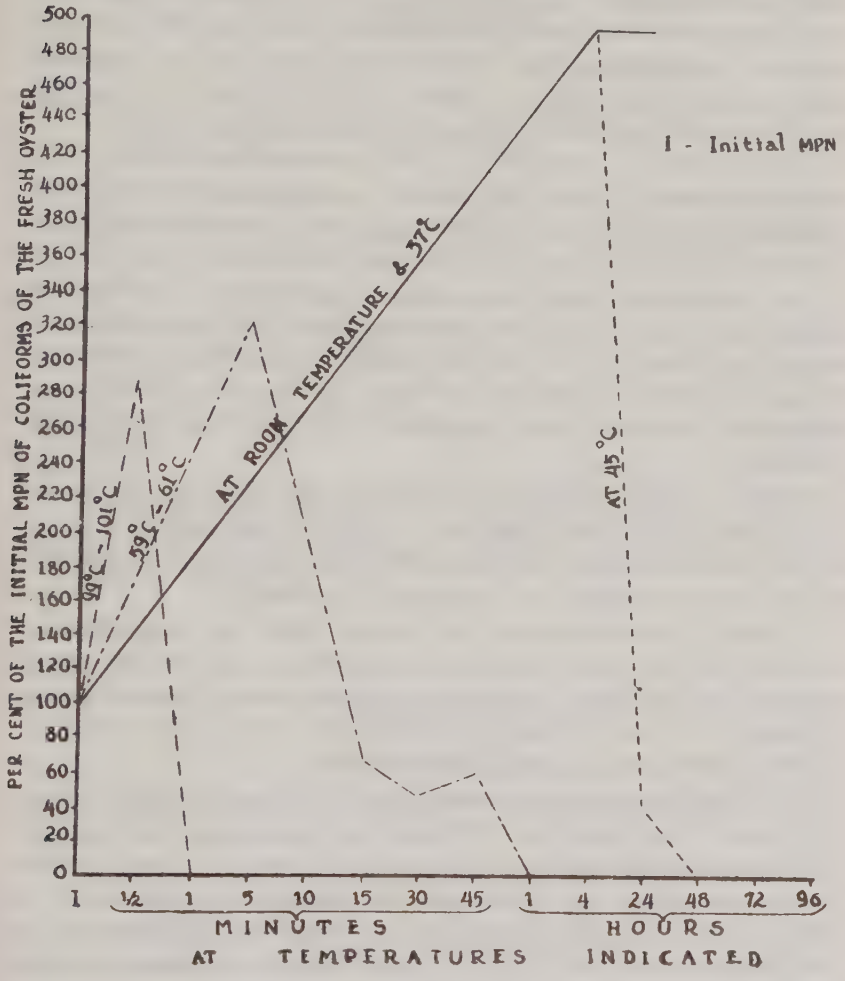


FIG. 4. Trends in the MPN of coliforms in heat-treated oysters.

dicates a negative CC, the members of the *Salmonella* group of organisms which might have been present, were destroyed. The results of the trials in which the oysters were subjected to 59°–61° C. (Table 4) are similar to those observed by Wilson and Miles.

SUMMARY AND CONCLUSIONS

Four series of experiments were conducted to determine the effect of salt, vinegar, and heat on the bacterial contents of oysters, particularly the coliforms. Two qualities of salt were used: one with 99.45 per cent sodium chloride (0.006 per cent moisture) and the other with 82 per cent sodium chloride (9.9 per cent moisture). Vinegar with 3.47 per cent acetic acid was used. Low degrees of heat, including RT, 37° C., 45° C., 59°–61° C., and 99°–101° C., were investigated. Salt concentrations of 10, 15, 20, and 25 per cent and vinegar concentrations of 10, 15, 20, 25, and 30 per cent in oyster specimens kept at RT, 37° C., and 45° C. were experimented.

The procedures and techniques employed as well as the methods of computation for obtaining the TBC and CC, were those described in a various paper (Salafranca, (1952). From the results obtained in these experiments, under the conditions and limitations specified, the following conclusions are drawn:

1. The periods of time required by salt concentrations of 10, 15, 20, and 25 per cent and vinegar concentrations of 10, 15, 20, 25, and 30 per cent to destroy the coliforms in oysters, are too long to be of any practical application.

2. These concentrations are rather high for palatability. Salt and vinegar in the usual concentrations used for seasoning oysters are, therefore, expected to be less efficient bactericides. The amount of salt normally employed may even be the optimum concentration for coliform multiplication.

3. Of the temperatures tried, 59°–61° C. and 99°–101° C. in the oyster mass itself are effective in destroying the coliform within practicable time—an average of about 1 hour at the former and about 15 minutes at the latter. Only 99°–101° C. heating may be easily adaptable for practical application. A temperature range of 59°–61° C. is difficult to maintain without special apparatus.

For practical purposes these observations are applicable to the other intestinal pathogens which may accompany the coliforms inasmuch as closely allied organisms generally behave in a similar manner (Salle, 1948; Wilson and Miles, 1946).

4. Vigorous boiling (99°–101° C.) for at least 15 minutes is the only safe and practicable pretreatment of oysters for table purposes, provided the oysters have been properly handled.

The objection to this treatment is that it results in excessive dehydration of the oysters; they lose their juicy tenderness and therefore their appeal, especially, to epicures.

BIBLIOGRAPHY

BAUMGARTNER, J. G. Canned Foods. 2d ed. (1946) 239 pp.

CLAGUE, J. A., and C. ALMARIO. Bacteriological studies of Philippine Fishery products. Research Report 27, Fish and Wildlife Service, U.S. Dept. of Interior, 12 pp.

Department of Agriculture. Order No. 13. Issued December 15, 1951.

Division of Public Health Laboratory, Manila Health Department. Memorandum for the city health officer covering a report on the sanitary quality of shellfish.

SALAFRANCA, E. S. A bacteriological survey of the oysters and shellfish-growing waters of the Binakayan oyster farm of the Bureau of Fisheries. Jour. Phil. Pub. Health Assn., Oct.–Dec., 1952.

SALLE, A. J. Fundamental Principles of Bacteriology. 3d ed. (1948) 730 pp.

WILSON, G. S., and A. A. MILES. Topley and Wilson's Principles of Bacteriology and Immunity. 1, 3d. ed. (1946) 970 pp.

ZOBELL, C. E. Marine Microbiology, A Monograph of Hydrobacteriology. 1946 ed. 230 pp.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Trends in the MPN of coliforms in oysters treated with granulated rock salt (99.45 per cent).

2. Trends in the MPN of coliforms in oysters treated with solar salt (82 per cent NaCl).

3. Trends in the MPN of coliforms in oysters treated with vinegar (acetic acid 3.47 per cent).

4. Trends in the MPN of coliforms in heat-treated oysters.

PROXIMATE CHEMICAL COMPOSITION OF VARIOUS SPECIES OF PHILIPPINE MARKET FISHES

By Jose I. Sulit, Olympia B. Navarro, Regina C. San Juan, and Elisa B. Caldito
Of the Bureau of Fisheries, Manila, Philippines

ONE TEXT FIGURE

INTRODUCTION

By knowing the proximate chemical composition according to species, sizes and different portions of the body of fishes, nutritionists are able to determine the approximate food value of various diets using fish as the main source of protein, fats, and minerals. This study also includes the determination of important minerals such as calcium, phosphorus, and potassium found in the ash.

The ravages of World War II destroyed the vast resources of protein food in many countries including the Philippines, making the prices of these foods beyond the buying capacity of an average family. Because of this condition, dietitians and nutritionists are searching for a substitute food rich in food value and yet cheap in price. It is hoped that the results of our studies may help solve some of these problems.

REVIEW OF LITERATURE

Investigations related to this study were conducted by Balagtas (1928), Santos and Ascalon (1931), and Hermano (1932) wherein the proximate chemical composition of a few species of Philippine fishes was included in their works. It has been found that the biological or nutritional quality of the protein, fats, minerals, and vitamins of various species of fish compares favorably with that of beef, veal, pork, lamb, and mutton. Le Cornu (1949) found that fish protein is rich in dietary essential amino acids, amongst them leucine, histidine, lysine, arginine, and tryptophane. Nilson (1946) revealed that fish protein is from 85 to 95 per cent digestible, and biological studies showed that all the dietary essential amino acids which are needed to give growth and maintenance to the body tissue are also present, and that an average serving of fish and shellfish will supply sufficient animal protein to satisfy the daily body requirements. Marks and Nilson (1946) proved in their studies

that baking, broiling, and simmering do not affect the protein food value of codfish. This claim was corroborated by Martinek and Goldbeck (1947) who studied the effect of baking on the protein food value of croaker fillet.

Le Cornu (1949) reported that the fats of some fishes have a high percentage of digestibility, determined as follows—mackerel, 95 per cent; butterfish, 86 per cent; and salmon, 94 per cent. According to Newell and McCollum (1931) the ash of fish fillet has relatively high amount of calcium, copper, iron, magnesium, phosphorus, potassium, sodium, and strontium, besides traces of aluminum and fluorine. In some samples analyzed by them, it was found that fish contains traces of barium, lead, chromium, silicon, tetanium, vanadium, and zinc, as well as traces of chlorine, sulfur, iodine, and bromine. According to Tarr et al. (1950), the vitamin B_{12} present in the fish soluble concentrate, spleen, liver, and fish meal, is one of the most important constituents commonly associated with the animal protein factor (APF). In the Menhaden Reductive Industry (1949), three important products were obtained, namely, the oil, the highly nutritive liquid mixture of proteins, soluble amino acids, and vitamin B_{12}, which, according to Dameshek (1949), is used in the cure of pernicious anemia.

Besides vitamins A and D found in the liver and body of fish, an average serving of fish meat supplies $\frac{1}{20}$ to $\frac{1}{15}$ of the daily allowance of B_1, $\frac{1}{25}$ to $\frac{1}{5}$ of B_2, and from $\frac{1}{10}$ to $\frac{1}{2}$ of niacine. The water soluble concentrates contain an appreciable amount of a newly discovered vitamin B_{12}. So much had been published about vitamin B_{12} that its use as growth-promoting compound is now beyond dispute. Exhaustive review of literature will reveal other more important aspects of fish as food.

MATERIALS AND METHODS

Preparation of the samples.—The different species of fish used in this study were obtained from market centers of Manila and from the catches of fishing boats of the Bureau of Fisheries. After determining the species, the fish was weighed, measured in standard length and depth, then scaled, finned and dressed. The edible portion or the fillet was removed and the rest of the flesh attached to the bones was added after softening by boiling, thereby obtaining the total edible portion. The percentage of non-edible portion is calculated by difference considering the whole fish as 100 per cent. After chopping, it is passed through

a meat grinder to produce a composite and homogenous mixture from which the different samples for analysis were taken.

Proximate chemical analysis.—The prepared samples obtained from different species of fish were analyzed for proximate chemical composition, namely, moisture, protein, fat, ash (minerals), and carbohydrates, calculated by difference. Also, the calories per one hundred grams of edible portion were calculated, based from the above analysis. Each gram of carbohydrates and proteins yields 4 calories, and each gram of fat, 9 calories (Table 1). Some species of fish were analyzed for proximate chemical composition with reference to sizes or weight, enumerated as large, medium, and small (Table 2). The different parts of the fish such as the head, belly, back and tail were also analyzed for proximate chemical composition (Table 3). These parts are shown in text fig. 1.

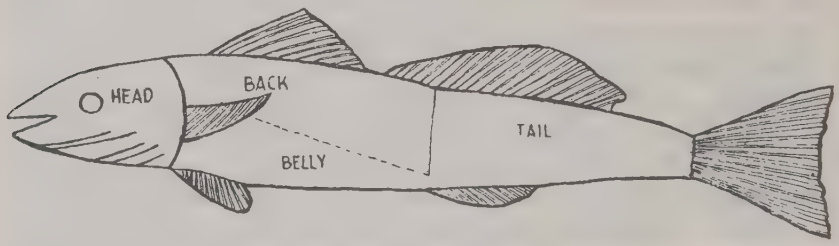


FIG. 1. Showing the different portions of the fish that were subjected to analysis.

Minerals of the ash of the edible portion.—In various species of fish commonly consumed in Filipino homes, the minerals of the ash of the edible portion were analyzed for calcium, phosphorus, and potassium. There has been no study conducted in this country where analysis for potassium is included in fish analysis. The samples used for the moisture determinations were ashed in the muffle furnace at 555°C., and the ashes obtained were utilized for the mineral determination (Table 4).

Methods used for chemical analysis.—For determining the proximate chemical composition of fish and calcium, the sixth edition of the Association of Official Agricultural Chemists (1945) was used as reference with little modification whenever necessary. For potassium and phosphorus, the diagnostic techniques for soil and crops (1948) and those of Fiske and Subbarrow (1925), and Lowry and Lopez (1946) were consulted, respectively.

RESULTS

Table 1 contains the proximate chemical composition and calorific food value of sixty-three species of Philippine market

fishes commonly found in market centers. In some species, analysis for minerals of the ash is also included. The edible portion of the fish is determined and the none-edible part is calculated by difference. Table 2 gives the chemical composition of different portions of fish such as the head, belly, back and tail as enumerated in fig. 1.

Table 3 shows the proximate chemical composition with regards to sizes and weight and standard length of some species of fish, the purpose of which is to determine the extent of variations in the chemical composition according to sizes, weight, and standard length.

Table 4 gives the mineral composition of the ash of the fillet of certain species of fish. These minerals are calcium, phosphorus, and potassium.

DISCUSSION OF RESULTS

As shown in Table 1, it is very significant that practically all the species analyzed have less than 5 per cent fat, indicating that the majority of Philippine fishes have lesser fat than those found in temperate waters. Because of this property, practically all edible fishes in Philippine waters may be converted into fish meal without any trouble of any fatty acid rancidity in the final product. Comercial fish meal generally contains not more than 5 per cent fat and with a moisture content of not more than 10 per cent in order to insure from the attacks of molds and other food spoilage agents. The average percentage of fish protein in many of our fishes is generally high, and there are some that are extraordinarily rich in protein, namely, *apahap, dorado, dalagang bukid, lapu-lapu, labahita, maya-maya, talakitok, tulingan,* herring, and other fresh-water fishes, such as *bia, dalag,* and *kanduli.* The mineral ash is high in some species such as *asohos, bakokong moro, bambangin, buan-buan, dalagang bukid, dapang bilog, dilis, dorado, hasa-hasa,* herrings, and the tunas (Table 1). Dilis is one particular species which is quite high in food value, being rich in protein, fat, and minerals, especially calcium and phosphorus (Table 4). As food and as fish meal for poultry and stock feed, dilis serves as an ideal raw material. The work of Navarro (1950) revealed that dilis is as good as milk in protein and mineral contents. This is abundantly found in Philippine waters and commonly dried and utilized in the form of salted fish paste (*bagoong*).

TABLE 1.—*Proximate chemical composition and calorific food value of some Philippine market fishes.*

Local name	Scientific name	Edible portion	Non-edible portion	Moisture	Ash (minerals)	Protein (N x 6.25)	Fat (E. E.)	Carbohydrate by difference	Calories per 100 grams of edible portion
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Agoot	*Pomadasys hasta*	47.68	52.32	77.46	1.28	21.11	0.21		92
Alumahan (large)	*Rastrelliger chrysozonus*	63.59	36.41	79.01	1.09	17.15	1.62	1.77	105
Alumahan (medium)	do	56.90	43.10	78.73	1.52	17.06	0.65	2.04	96
Alumahan (small)	do	55.86	44.15	79.33	1.07	16.57	0.48	2.45	92
Apahap	*Lates calcarifer*	61.90	38.10	79.67	0.98	18.90	0.28	0.17	79
Asohos	*Sillago sihama*	57.77	43.23	74.48	2 12	20.41	1.17	1.82	100
Bakokong moro	*Sparus berda*	57.44	42.56	73.59	2.53	21.85	0.51	1.52	98
Balila	*Trichiurus haumela*	68.59	31.41	77.11	1.68	17.89	2.11	1.23	95
Bambangin	*Lutjanus fulvus*	65.96	34.04	78.38	1.14	19.65	0.41	0.42	84
Banak	*Mugil vaigiensis*			73.15	1.45	20.41	2.55	2.44	114
Bangos (large)	*Chanos chanos*	67.10	32.90	71.97	1.51	20.57	5.28	0.67	133
Bangos (medium)	do	61.64	38.36	71.15	1.05	20.73	5.67	1.40	144
Bia (large)	*Glossogobius giurus*			80.67	1.32	18.28	0.43		77
Bia (medium)	do			80.93	1.22	17.26	0.36	0.23	73
Bia (small)	do			81.49	1.14	17.54	0.29		73
Bidbid	*Elops hawaiensis*	56.99	43.01	77.10	1.32	19.25	1.59	.74	94
Bisugo	*Nemipterus taenipterus*	53.31	46.69	77.77	1.38	17.56	1.15	2.14	89
Buan-buan	*Megalops cyprinoides*	53.17	46.83	76.65	1.07	17.04	3.66	1.58	107
Buguing	*Hemiramphus far*	64.88	35.12	80.33	0.60	17.23	1.41	0.43	83
Butete	*Tetraodon* sp.	44.68	55.32	77.85	0.30	19.52	1.71	0.62	96
Butterfly fish	*Chaetodon* sp.	58.47	41.53	78.87	1.13	20.00	1.47		93
Dalag	*Ophicephalus striatus*	69.05	30.95	79.79	0.21	18.88	1.20		86
Dalagang bukid (large)	*Caesio cuning*	68.80	31.20	77.87	1.55	19.86	0.64	0.08	88
Dalagang bukid (medium)	do	70.74	29.26	78.11	1 27	18.93	0.27	1.42	85
Dalagang bukid (small)	do	71.71	28.29	78.00	1.42	20.42	0.47		86
Dalagang bukid	*Caesio lunaris*	70.71	29.29	77.69	1.26	19.35	0.57	0.13	83
Dalagang bukid	*Caesio caerulaureus*	74.27	25.73	80.01	1.45	17.37	0.91	.26	97
Damis	*Hynnis momsa*	70.77	29.23	76.10	1.35	20.99	1.66		99
Damis lawin (large)	*Alectis indicus*	65.90	34.10	77.80	1.44	17.63	0.30	2.83	85
Damis lawin (small)	do	43.18	56.82	80.35	0.43	18.17	1.18		83
Dapang bilog	*Pseudorhombus oligodon*	68.51	31.49	77.07	2.29	17.34	2.52	0.78	95

TABLE 1.—*Proximate chemical composition and calorific food value of some Philippine market fishes*—Continued

Local name	Scientific name	Edible portion	Non-edible portion	Moisture	Ash (minerals)	Protein (N x 6.25)	Fat (E. E.)	Carbohydrate by difference	Calories per 100 grams of edible portion
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Dapang sinilas (large)	*Cynoglossus puncticeps*	67.38	32.62	79.31	1.64	17.72	2.13	----------	90
Dapang sinilas (small)	do	61.92	38.08	80.78	1.39	16.29	.24	1.30	81
Dilis (mature)	*Stolephorus commersonii*	100.00	None	74.44	3.57	20.74	1.40	----------	96
Dilis (young)	do	100.00	None	77.61	2.42	16.93	1.30	1.74	94
Dilis (mature)	*Stolephorus indicus*	100.00	None	73.71	3.60	19.49	1.51	1.69	98
Dorado (large)	*Scomberoides lysan*	69.02	30.98	75.84	2.06	22.73	0.48	----------	95
Dorado (small)	do	68.15	31.85	76.52	1.75	19.34	2.07	0.32	88
Duhay (large)	*Stromateus niger*	64.72	35.28	79.12	0.42	17.76	1.36	1.34	89
Duhay (small)	do	57.59	42.41	79.86	1.33	16.21	1.33	2.27	99
Galongong	*Decapterus macrosoma*	71.24	28.76	74.19	1.81	21.90	0.95	1.15	101
Gele	*Rachycentron canadus*	63.01	36.99	78.30	1.34	18.42	4.00	----------	110
Hasa-hasa	*Rastrelliger brachysomus*	65.74	34.26	75.12	2.16	20.88	0.92	0.92	95
Hito	*Clarias batrachus*	54.35	45.65	79.90	2.12	16.45	1.27	0.26	78
Ilak	*Kyphosus lembus*	62.04	37.96	75.91	1.11	21.07	1.96	----------	102
Kabasi (large)	*Anodontostoma chacunda*	53.09	46.91	77.35	2.88	18.20	1.53	0.04	87
Kalaso (large)	*Saurida tumbil*	64.30	35.70	77.29	1.48	19.54	0.79	0.90	89
Kalaso (small)	do	63.05	36.95	78.56	1.34	20.60	0.47	----------	104
Kanduli	*Arius thalassinus*	79.00	21.00	79.27	1.20	18.18	0.75	0.60	82
Kanduling bongoan	*Arius leiotetocephalus*	51.31	48.69	78.07	1.34	21.21	0.52	----------	90
Kitang	*Scatophagus argus*	39.43	60.57	77.00	0.90	18.83	1.30	1.97	95
Labahita	*Acanthurus bleekeri*	63.48	36.52	79.77	1.14	19.19	0.43	----------	81
Lapu-lapu (large)	*Plectropomus sp.*	68.77	31.23	78.84	1.07	20.79	0.31	----------	86
Lapu-lapu (medium)	do	67.54	32.46	79.65	1.03	19.25	0.38	----------	80
Lapu-lapu (small)	do	64.11	35.89	79.24	0.91	19.05	0.27	0.53	81
Malakapas	*Gerres filamentosus*	58.27	41.73	78.85	2.24	17.70	1.28	----------	82
Malaking mata (large)	*Monotaxis grandioculis*	49.37	50.63	78.37	0.80	19.04	1.75	0.04	92
Malaking mata (small)	do	43.35	56.75	79.22	1.43	17.11	0.63	1.61	89
Mamale	*Eleutheronema tetradactyla*	75.41	24.59	77.32	1.30	19.31	1.89	0.18	95
Maya-maya (large)	*Lutjanus malabaricus*	56.64	43.36	78.80	1.04	17.66	0.81	1.69	85
Maya-maya (small)	do	42.92	57.08	79.66	1.87	17.96	1.19	----------	83
Mayang (large)	*Drepane punctata*	61.59	38.41	76.80	1.32	21.17	0.34	0.37	89
Mayang (small)	do	51.59	48.41	78.11	1.31	18.14	1.42	1.02	89

TABLE 1.—*Proximate chemical composition and calorific food value of some Philippine market fishes*—Continued

Local name	Scientific name	Edible portion	Non-edible portion	Moisture	Ash (minerals)	Protein (N x 6.25)	Fat (E. E.)	Carbohydrate by difference	Calories per 100 grams of edible portion
		Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	
Oriles	*Megalaspis cordyla*	62.06	37.94	76.00	1.24	19.63	1.51	1.62	99
Palos	*Synbranchus bengalensis*	55.99	44.01	81.40	0.36	16.10	1.16	1.98	78
Parang-parang	*Chirocentrus dorab*	71.19	28.81	75.23	2.15	20.20	0.91	1.51	95
Pating	*Scoliodon palasorrah*	64.43	35.57	76.29	0.51	21.25	2.36	----------	106
Pindanga	*Muraenesox cinereus*	94.73	5.27	78.04	0.63	18.97	1.53	0.83	93
Salay-salay aso	*Caranx kalla*	65.74	34.26	76.57	1.22	19.16	1.67	1.38	97
Samaral (large)	*Teuthis javis*	55.69	44.31	80.05	0.33	17.35	0.99	1.28	83
Samaral (medium)	------do------	50.66	49.34	79.18	1.10	20.90	0.58	----------	89
Sap-sap (large)	*Leiognathus equulus*	44.76	55.24	79.50	1.46	17.32	1.12	.60	82
Sap-sap (medium)	------do------	42.99	57.01	79.36	1.88	17.70	1.38	.60	85
Sap-sap (small)	------do------	44.36	55.64	80.99	1.07	16.67	.50	.77	74
Spanish mackerel (large)	*Cybium commerson*	74.08	25.92	76.66	1.53	18.34	0.87	2.60	92
Spanish mackerel (medium)	------do------	68.47	31.53	78.12	1.49	17.09	0.35	2.95	83
Spanish mackerel (small)	------do------	64.99	35.01	78.80	1.59	16.44	0.34	2.83	80
Sunog	*Platycephalus indicus*	60.45	39.55	79.95	1.93	17.59	1.29	----------	82
Talakitok (large)	*Caranx sexfasciatus*	69.97	30.03	77.49	1.35	22.04	0.43	----------	92
Talakitok (medium)	------do------	66.05	33.95	77.77	1.08	20.46	0.45	0.24	87
Talakitok (small)	------do------	62.80	37.20	78.80	1.03	20.16	0.42	----------	84
Talipa (small)	*Scomeroides lysan*	68.98	31.02	76.40	1.34	20.68	1.75	----------	98
Talilong	*Mugil dussumieri*	53.86	46.14	72.25	1.83	20.49	3.55	1.88	121
Tamban (herring)	*Sardinella longiceps*	60.00	40.00	75.64	1.26	21.01	1.89	.10	91
Torcillo (large)	*Sphyraena jello*	62.36	37.64	77.69	1.78	18.79	0.22	1.52	77
Torcillo (medium)	------do------	61.30	38.70	75.62	1.68	19.15	1.35	2.20	98
Torcillo (small)	------do------	67.83	32.17	76.36	1.80	19.33	1.22	1.29	93
Tulingan (large)	*Auxis thazard*	71.22	28.78	72.32	1.38	22.86	1.96	1.48	105
Tulingan (medium)	------do------	64.07	35.93	72.10	1.65	24.47	0.62	1.16	108
Tulis (herring)	*Dussumieria acuta*	78.15	21.85	76.10	1.99	19.19	1.40	1.32	95
Tunsoy (herring)	*Sardinella fimbriata*	76.16	23.84	75.87	2.31	19.87	1.36	0.59	94

In Table 2 the proximate chemical composition of the different parts of fish reveals that there is little variation in the protein and ash contents; however, it is very significant that in most cases the fat is higher in the head and belly as shown in *apahap, banak, bisugo, buan-buan, iso, oriles,* and *salmon* The protein which is low in the head is equally distributed in the belly, back and tail. The percentage of ash does not vary so much in all portions of the fish except for a tendency of the amount decreasing in the head.

The result as shown in Table 3 reveals that the percentages of edible portion and food value in many cases are higher in bigger fishes.

Dalagang-bukid which is available in market centers throughout the year is cheap in price as compared with talakitok, lapulapu, oriles, and the tunas, yet it is comparatively high in food value.

The majority of Philippine market fishes have higher percentage of phosphorus than some common North American fishes (Table 4). In some species the percentage of calcium is also greater. The species that are high in both phosphorus and potassium are *alumahan, banak, biang puti, dalagang bukid, damis lawin,* dilis, and others (Table 4).

Phosphorus and potassium are two important elements found in the brain and cell tissues of organic living things and also responsible in the cure of arthritis and cancer.

SUMMARY AND CONCLUSION

In an attempt to determine the food value of various species of Philippine market fishes, their proximate chemical compositions were analyzed with reference to size, standard length, and different portions of the fish.

1. Sixty-three species of fish commonly found in market centers were analyzed for moisture, ash, protein, fats, minerals, and carbohydrates (calculated by difference), and their calorific food value;

2. In most cases, the edible portion and food value are higher in bigger fishes than in the smaller ones of the same species;

3. In many instances, the percentage of fat is higher in the belly and head, while the protein which is almost equally distributed in the belly, back and tail of the fish is quite low in the head;

TABLE 2.—*Showing the proximate chemical composition of different portions of the body of some large-sized market fishes.*

Local name	Scientific name	Parts of fish	Moisture	Protein (N x 6.25)		Fat (E. E.)		Ash (minerals)	
				Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Agoot	*Pomadasys hasta*	Back	77.46	21.11	93.66	0.21	0.93	1.28	5.68
		Belly	76.50	22.61	96.21	0.19	0.80	1.32	5.62
		Tail	77.28	21.86	96.21	0.28	1.23	1.23	5.41
		Head	75.55	17.65	72.19	5.93	24.25	1.33	5.44
Apahap	*Lates calcarifer*	Back	75.41	17.40	70.76	1.54	6.54	1.27	5.16
		Belly	75.13	18.56	75.54	1.97	8.39	0.98	3.99
		Tail	76.47	17.81	75.69	1.59	6.74	1.06	4.50
		Head	76.25	16.67	70.19	2.94	12.36	0.94	3.95
Banak	*Mugil vaigiensis*	Back	74.28	16.91	65.75	1.50	5.83	1.70	6.61
		Belly	70.71	21.94	74.91	4.63	15.81	1.41	4.81
		Tail	74.47	22.39	87.82	1.52	5.95	1.24	4.86
		Roe	55.53	25.20	56.67	13.94	31.35	2.35	9.14
Bangos	*Chanos chanos*	Back	71.34	22.91	79.94	3.82	13.34	1.57	5.48
		Belly	67.62	22.42	69.24	7.67	23.70	1.18	3.64
		Tail	71.93	23.20	82.65	3.04	10.84	1.28	4.56
		Head	79.80	13.58	69.23	6.18	30.59	1.17	5.79
Bid-bid	*Elops hawaiensis*	Back	72.90	19.53	72.07	1.66	6.14	1.32	4.87
		Belly	70.26	18.99	63.85	2.35	7.91	1.30	4.37
		Tail	72.66	19.70	72.06	0.90	3.29	1.26	4.61
		Head	75.64	16.27	66.79	0.62	2.55	1.02	4.19
Bisugo	*Nemipterus taenipterus*	Back	79.65	15.26	74.99	0.61	2.99	1.23	6.04
		Belly	80.09	14.92	74.94	0.62	3.10	1.05	5.27
		Tail	79.07	15.66	74.82	0.48	2.99	1.11	5.30
		Head	80.25	14.32	72.51	0.80	4.03	1.14	5.77
Buan-buan	*Megalops cyprinoides*	Back	76.18	17.86	74.98	0.67	2.83	1.12	4.70
		Belly	76.71	17.05	73.21	0.78	3.35	1.04	4.38
		Tail	75.79	17.54	72.45	0.63	2.62	1.08	4.46
		Head	77.85	15.69	70.84	1.02	4.81	1.0,	4.79

TABLE 2.—*Showing the proximate chemical composition of different portions of the body of some large-sized market fishes*—Continued

Local name	Scientific name	Parts of fish	Moisture	Protein (N x 6.25)		Fat (E. E.)		Ash (Minerals)	
				Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
			Per cent	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Gele	*Rachycentron canadus*	Back	78.35	15.84	73.16	0.32	1.50	1 38	6.37
		Belly	78.71	15.45	72.57	0.36	1.71	1.08	5.07
		Tail	77.58	16.98	75.74	0.43	1.92	1.31	5.84
		Head	80.08	14.02	70.38	0.54	2.69	1.07	5.37
Iso	*Lutjanus* sp.	Back	78.38	16.73	77.38	0.92	4.26	1.06	4.90
		Belly	77.51	16.17	71.90	1.28	5.70	1.34	5.96
		Tail	77.83	15.85	71.47	0.75	3.37	1.06	4.78
		Head	74.22	16.98	65.87	8.52	33.03	0.90	3.49
Lapu-lapu	*Epinephelus corallicola*	Back	79.13	16.40	70.58	0.37	1.77	1.59	7.62
		Belly	77.38	15.59	68.92	0.37	1.64	1.28	5.66
		Tail	78.28	15.72	72.38	0.54	2.48	1.06	4.88
		Head	77.48	14.65	68.08	0.79	3.52	1.15	5.34
O'iles	*Megalaspis cordyla*	Back	73.34	17.00	64.74	1.42	5.42	1.18	4.49
		Belly	70.91	17.06	58.65	2.59	8.91	1.01	3.47
		Tail	74.82	18.05	71.68	0.97	3.87	1.19	4.73
		Head	75.11	14.55	58.53	1.99	7.99	0.96	.86
Salmon	*Elagatis bipinnulatus*	Back	74.39	22.86	89.26	1.66	6.48	1.68	6.56
		Belly	72.90	22.87	84.39	2.99	11.03	1.63	6.01
		Tail	73.44	23.59	88.82	1.51	5.69	1.65	6.21
		Head	74.42	18.55	72.52	4.83	18.88	1.47	5.57
Talakitok	*Caranx malabaricus*	Back	76.55	16.32	69.34	1.11	4.75	1.45	6.18
		Belly	76.89	17.02	73.65	1.20	5.21	1.37	5.98
		Tail	76.33	17.06	72.07	1.32	5.57	1.24	5.04
		Head	75.41	15.58	64.58	2.21	9.00	1.08	4.39

TABLE 3.—*Proximate chemical composition of some Philippine market fishes at different sizes.*

Name of fish	Standard length	Depth	Weight	Edible portion	Non-edible portion	Moisture basis	Protein (N x 6.25)		Fat (E. E.)		Ash (minerals)	
							Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
	cm.	*cm.*	*gm.*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*	*Per cent*
Rastrelliger chrysozonus:												
1. Alumahan	24	7	321.9	63.59	36.41	79.01	17.15	81.70	1.62	7.71	1.09	5.19
2. Alumahan	21	6	196.5	56.90	43.10	78.73	17.03	80.16	0.65	3.05	1.52	7.14
3. Alumahan	19.5	5	128.2	55.85	44.15	79.33	16.57	80.11	0.48	2.32	1.07	5.12
Chanos Chanos:												
1. Bangos	26.5	8	472.3	67.10	32.90	71.97	20.57	74.18	5.28	19.60	1.51	4.62
2. Bangos	23.5	6	238.5	61.64	38.36	71.15	20.73	71.85	5.67	19.64	1.05	3.64
Glossogobius giurus :												
1. Biang puti	23	5	219			80.67	18.28	94.57	0.43	2.22	1.32	6.82
2. Biang puti	18	3	95.5			80.93	17.26	90.51	0.36	1.89	1.22	6.40
3. Biang puti	14.5	2.5	93.5			81.49	17.54	94.76	0.29	1.57	1.14	6.16
Caesio cuning:												
1. Dalagang bukid	25	8	457.7	68.80	31.20	77.87	19.86	89.74	0.64	2.89	1.55	7.00
2. Dalagang bukid	24	8.5	428.2	70.27	29.73	77.78	20.60	92.71	0.57	2.57	1.47	6.62
3. Dalagang bukid	21.5	8.5	310.7	70.74	29.26	78.11	18.93	86.48	0.27	1.23	1.27	6.45
4. Dalagang bukid	20	7	271 8	71.71	28.28	78.00	20.42	92.22	0.47	2.13	1.42	6.45
Stolephorus commersonii:												
1. Dilis, young				100		75.61	16.93	69.41	1.30	5.33	2.42	9.91
2. Dilis, mature				100		74.44	20.74	81.14	1.40	5.48	3.57	13.97
tolephorus indicus:												
Dilis, mature				100		73.71	19.49	74.14	1.51	5.74	3.57	13.97
Therapon theraps:												
1. Gagaong	24	9	459.5	59.87	40.13	76.81	16.82	72.53	1.50	6.47	1.11	4.79
2. Gagaong	22	7.5	289.9	56.50	43.50	78.27	17.35	79.84	1.20	5.53	1.05	4.83
3. Gagaong	15.5	5	81.3	51.49	48.51	76.21	17.23	72.43	2.92	12.29	0.68	2.86
Plectropomus sp.:												
1. Lapu-lapu	32.0	9.5	758.5	68.77	31.23	78.84	20.79	98.25	0.31	1.47	1.07	5.06
2. Lapu-lapu	27.5	8	445.8	67.54	32.46	79.65	19.25	94.59	0.38	1.87	1.03	5.06
3. Lapu-lapu	22.5	6.5	254.1	64.11	35.89	79.24	19.05	91.76	0.27	1.30	0.91	4.37

TABLE 3.—*Proximate chemical composition of some Philippine market fishes at different sizes*—Continued

Name of fish	Standard length	Depth	Weight	Edible portion	Non-edible portion	Moisture basis	Protein (N x 6.25)		Fat (E. E.)		Ash (minerals)	
							Fresh basis	Dry basis	Fresh basis	Dry basis	Fresh basis	Dry basis
Leiognathus equulus:												
1. Sapsap	16	10	164	44.76	55.24	79.50	17.32	84.49	1.12	5.47	1.46	7.12
2. Sapsap	13.5	9.0	110.5	42.99	57.01	79.36	17.70	83.33	1.38	6.70	1.08	5.34
3. Sapsap	10.5	7.5	68.5	44.36	55.64	80.99	16.67	87.69	0.50	2.44	1.07	5.63
Cybium commerson:												
1. Spanish mackerel	32	6.5	337.9	74.08	25.92	76.66	18.34	78.58	0.87	3.72	1.53	6.56
2. Spanish mackerel	25.5	5.5	184.6	68.47	51.53	78.12	17.09	77.11	0.35	1.60	1.49	6.81
3. Spanish mackerel	24.3	4.3	90.4	64.99	35.01	78.80	16.44	77.55	0.34	1.62	1.59	7.50
Caranx sexfasciatus:												
1. Talakitok	26	12	624.4	69.97	30.03	77.49	22.04	97.91	0.43	1.91	1.35	6.00
2. Talakitok	23	9.5	335.5	66.05	33.95	77.77	20.46	92.04	0.45	2.02	1.08	4.86
3. Talakitok	13	8	186	62.80	37.20	78.80	20.16	95.55	0.42	1.98	1.03	4.88
Sphyraena jello:												
1. Torcillo	34.5	4	259.0	62.36	37.64	77.69	18.79	84.22	0.22	1.0	1.78	7.98
2. Torcillo	21.0	3.5	186.8	61.30	38.70	75.62	19.15	78.55	1.35	5.53	1.68	6.89
3. Torcillo	17	3	115.0	67.83	32.17	76.36	19.33	80.77	1.22	5.17	1.80	7.61

TABLE 4.—*Mineral components of various Philippine market fishes (estimated in milligrams per 100 grams of fresh sample).*

Local name	Scientific name	Ash	Ca	P	K
		Per cent			
Alumahan	*Rastrelliger chrysozonus*	1.09	42	622	176
Banak	*Mugil vaigiensis*	1.47	15	484	259
Bangos	*Chanos chanos*	1.05	16	264	94
Biang puti	*Glossogobius giurus*	1.35	50	537	272
Dalagang bukid	*Caesio cuning*	1.27	36	565	264
Damis lawin	*Alectis* sp.	1.44	26	658	274
Dilis	*Stolephorus commersonii*	3.57	178	1,690	511
Dapang sinelas	*Cynoglosus* sp.	1.39	32	436	283
Dorado	*Scomberoides lysan*	2.06	95	1,005	266
Duhay	*Stromateus niger*	1.33	17	506	203
Gagaong	*Therapon theraps*	1.11	41	435	216
Ilak	*Kyphosus lembus*	1.11	36	488	226
Kalaso	*Saurida tumbil*	1.34	16	303	266
Kanduling bongoan	*Arius leiotetocephalus*	1.34	14	440	224
Labahita	*Acanthurus bleekeri*	1.14	21	503	243
Lapu-lapu	*Plectropomus* sp.	1.07	27	195	138
Malaking mata	*Monotaxis grandoculis*	1.43	58	478	161
Maya-maya	*Lutjanus malabaricus*	1.87	65	778	293
Samaral	*Teuthis javus*	1.10	42	455	192
Sapsap	*Leiognathus equulus*	1.31	33	554	218
Spanish mackerel	*Cybium commerson*	1.53	149	462	305
Talakitok	*Caranx malabaricus*	1.26	27	501	260
Torcillo	*Sphyraena jello*	1.50	22	598	307
Foreign Fish					
Haddock		1.20	19	197	------
Halibut		1.00	13	234	540
Herring		1.30	101	272	------
White fish		1.60	150	263	------
Blue fish		------	23	235	------
Tuna, canned		2.10	8	224	480

4. The variations in the amount of ash in each species are rather insignificant irrespective of size, standard length and any portion of the fish;

5. The calcium and phosphorus contents in some are higher than those of the North American fishes, namely, the halibut, haddock, and herring;

6. The low fat content of practically all Philippine market fishes analyzed indicates that they may be suitable for fish meal manufacture without any danger of the free fatty acid rancidity which makes the product inferior in quality. A good commercial fish meal must contain not more than 5 per cent fat and 10 per cent moisture; and

7. Dilis is a good source of protein, calcium, and phosphorus. Because of its abundance in Philippine waters practically throughout the year, its greater utilization will undoubtedly help improve the Filipino diet.

REFERENCES

BALAGTAS, A. N. The chemical composition of Philippine fishes. Phil. Agric. 17 No. 5 (1928) 253–260.

BEAR, E. F. ET AL. Diagnostic technique for soils and crops. American Potash Institute, Wash. 6, D. C. (1948).

DAMESHEK, W. Recent clinical experience with vitamin B_{12}. Blood 4 (1949) 76.

FISKE, C. H., and Y. J. SUBBARROW, Determination of inorganic phosphorus. Journ. Biol. Chem. 66 (1925) 375.

GOWANLOCK, J. N. Menhaden: Facts and fallacies. Mississippi Food Commission Biloxi, Mississippi (1949).

HERMANO, A. J. Food values. Bur. of Science. Dept. of Agric. & Nat. Res. Bur. of Printing. Manila, Philippines (1932).

LE CORNU, L. R. High food value of fish. Fisheries Newsletter 8 No. 6 (1949) 10.

LOWRY, O. H., and J. A. LOPEZ. Determination of inorganic phosphorus. Journ. Biol. Chem. 162 (1946) 421.

MARTINEK, A., and C. G. GOLDBECK. Nutritive value of baked croaker. Comm. Fish. R. (1947) 9–13. U.S. Dept. of the Interior.

MARKS, L. A., and H. W. NILSON. Effects of cooking on the nutritive value of the protein of cod. Comm. Fish Review 8 No. 12 (1946) 1–6. U.S. Dept. of the Interior.

NAVARRO, O. B. The availability of calcium in *bagoong* and *dilis*. Univ. of Mass., Amherst, Mass. (1950).

NEWELL, J. M., and E. V. MCCOLLUM. Mineral content of fish. U.S. Bur. Fish. Investigational Report No. 5 (1931).

NILSON, H. W. The food value of fish and shellfish. U.S. Fish and Wildlife Service Fishery Leaflet 36 (1946).

SANTOS, F. O., and S. J. ASCALON. Amount of nutrients in Philippine food materials. Philippine Agriculturist 20 (1931) 405–406.

TARR, H. L., B. A. SOUTHCOTT, and P. W. MAY. Vitamin B_{12}—active substances in fish products. Food Technology 4 No. 9 (1950) 354–357.

ILLUSTRATION

TEXT FIGURE

FIG. 1. Showing the different portions of the fish that were subjected to the analysis.

THE PHILIPPINE
JOURNAL OF FISHERIES

VOL. 2 JULY–DECEMBER, 1953 No. 2

THE GOBY DREDGE-TRAWL FISHERY OF LAGUNA DE BAY, WITH NOTES ON THE COMPOSITION OF THE COMMERCIAL CATCHES

By PORFIRIO R. MANACOP and SANTIAGO R. CAPCO
Of the Bureau of Fisheries
Department of Agriculture and Natural Resources
Manila

FIVE PLATES AND ELEVEN TEXT FIGURES

INTRODUCTION

The goby dredge-trawl fishery is comparatively a new industry, being developed during the postliberation period. At the close of 1950 it became an established industry along Rizal Province side of Laguna de Bay. This industry consists principally of the catching of white goby, *biyang puti* (*Glossogobius giurus*), with the use of an indigenous dredge-trawl gear operated on fishing dugouts. The gear was formerly employed in gathering fresh-water mollusks, which are the basic feed of the commercially raised ducks (*Anas boschas*) around the lake. Conservative estimate in 1950 placed the value of the industry in the neighborhood of 160,000 pesos worth of fishing craft, equipment and accessories. The extensive operation of this new fishing gear has resulted in various conflicts, if not in competition, with the other commercial fishing gear used in Laguna de Bay. As a consequence, two controversial views on the destructive effect of the gear have prevailed. One group claims it is a destructive gear to the demersal fishery; the other claims otherwise. In view of these

conflicting claims, some studies on the gear and its operation, as well as on the composition of the catches, were undertaken to determine its effects on the fishery resources.

Laguna de Bay (text fig. 1) is the largest fresh-water lake in the Philippines with an estimated area of about 930.7 square kilometers,[1] excluding Talim Island. It is a relatively shallow,

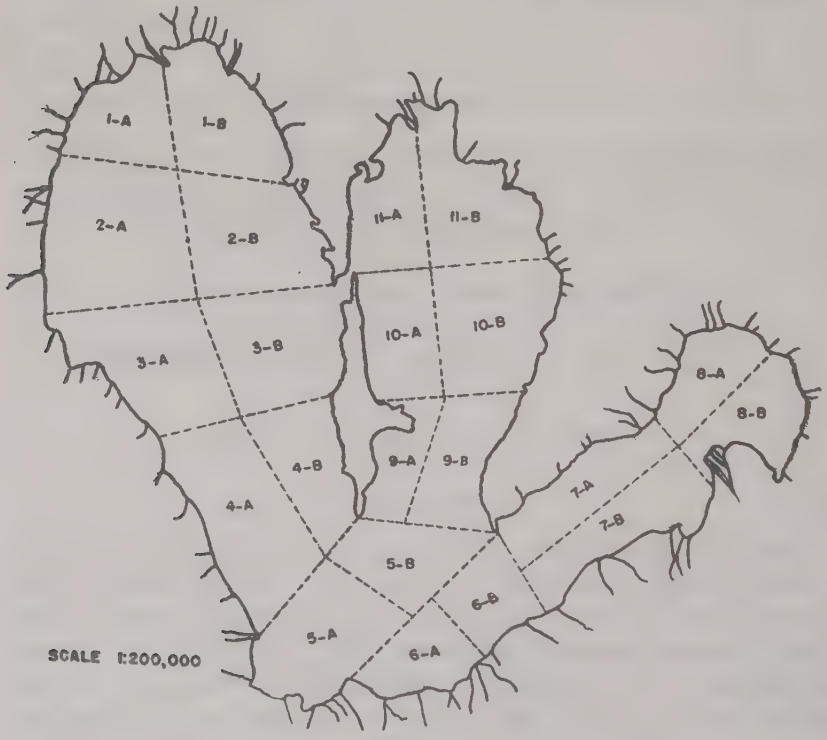


FIG. 1. Map of Laguna de Bay showing divisions of reference areas.

flat and muddy lake with a depth ranging from 3.5 meters in the middle area to 22 meters at a point near Diablo Pass. The average depth of the trawlable area (approximately 850 square kilometers) is about three meters. The nature of the bottom is generally of soft mud with sandy littoral areas near the mouths of inflowing rivers. The areas around the small island and headlands are generally rocky and muddy. These conditions of relative shallowness, muddy smooth bottom and almost perennial turbidity of the water make it ideal for the growth and multiplication of melanid snails and clams as well

[1] Aldaba, Vicente. The dalag fishery of Laguna de Bay. Phil. Jour. Sci. 46 (1931) 41–57.

as for the operation of dragnets, fish-corrals and gillnets in the lake throughout the year.

INTRODUCTION OF THE GOBY DREDGE-TRAWL AND OTHER TRAWLS IN LAGUNA DE BAY

The dredge trawl was evidently evolved from the age-old snail dredge trawl (*kaladkad*) commonly used in the commercial gathering of clams and snails used by the duck industry around Laguna de Bay. As far as it could be ascertained the fishermen of the municipalities of Pasig, Pateros, Taguig, and Binangonan, Rizal Province, were the originators of this goby dredge trawl.

As early as 1943 some experimental tests of the dredge trawl were conducted by Pasig and Pateros fishermen. But during the boom of the duck-raising industry in 1945–1947, the use of the dredge trawl ceased for sometime. However, immediately after the major collapse of the duck industry brought about by the typhoon "Jean" on December 26, 1948, the dredge trawl was revived by fishermen of Laguna de Bay as a means of livelihood. A much improved design, which was developed by the fishermen of Barrio Kalinawan, in the municipality of Binangonan, Rizal Province, came into use.

The original contrivance was a one- or two-dredge-trawl nets towed by a sailing fishing craft. Later in 1949–1950 motorized fishing crafts and motorlaunches towing three to four nets from a fishing craft were used. This motorlaunch-towed fishing craft was initiated by Pasig snail fishermen who fished alternately or wholly for snail and/or fish. With the collapse of the duck-raising industry in 1948–1949, a large number of the fishing craft formerly used in the snail fishery were converted into dredge trawlers purposely for *biya*, hence, the local name "*kalad kad pambiya*".

In 1949 a commercial beam trawl gear (Japanese utase) operated on a 60-foot motorlaunch was tried with success in Laguna de Bay, but many fishermen in the lake objected to its use. It damaged a lot of set lines (*kitang*) and gill-nets (*pante*) besides offering stiff competition with other fishing gear. However, it ceased operation after a few months. A small experimental otter trawl was also used by the Bureau of Fisheries for the purpose of assaying the bottom resources of the lake. The operation of the beam and otter trawl was often beset by constant digging-in of the foot-rope on the very

soft bottom of the lake. To offset this difficulty, flat stone weights and footrope seized with old netting were used.

THE FISHERMEN

Two or three men form the fishermen crew of sailboats and motorized craft. Each fishing craft is generally owned by the "head" fisherman who usually acts both as the pilot and as master fisherman. The crew are usually paid on the share basis of the catch. After deducting the operating expenses, 25 per cent of the net return goes to the vessel and gear, and the remaining 75 per cent is equally divided among the crew. Since this group of fishing vessel is less than three tons gross, a licensed skipper or engineer is not required as in a motorlaunch-towed fishing craft.

In motorlaunch-towed fishing craft, 50 per cent of the net return goes to the towing motorlaunch, 25 per cent to the towed fishing craft and fishing equipment, and 25 per cent to the fishermen. However, if the towing motorlaunch and towed fishing craft are both owned by the same person, the fishermen are paid on the daily basis of from 3 pesos to 4 pesos each. The towed fishing craft is usually manned by three or four fishermen and the towing motorlaunch by two or three men, a licensed skipper and two deckhands.

THE FISHING CRAFT

On the basis of the nature and mode of propulsion, the fishing craft are classified into three categories, namely, sailboat, motorized and motorlaunch-towed craft. Table 1 shows

TABLE 1.—*Number and kind of dredge-trawler units operating in Laguna de Bay (as of August, 1950).*

Kind	Number
Sailboat craft	184
Motorized craft	12
Motorlaunch-towed craft	4
TOTAL	200

that of the 200 operating units reported in August, 1950, 184 were sailboats, 12 motorized and four motorlaunch-towed fishing craft. Motor power used ranged from single, double to four cylinder gasoline engine (8 to 15 horsepower, air- or water-cooled types) which are installed on large dugout craft.

The fishing craft proper consists of the conventional wooden dugout which varies in size and mode of rigging for the dif-

ferent categories. The dugout is shaped out of a log or *mayapis, Shorea palosapis* (Blanco) Merr., and side plankings of *palosapis, Anisoptera thurifera* (Blanco) Merr., are added to increase the free board of the fishing craft.

Sailboat fishing craft (*Plate 1, fig. 1; text fig. 2*).—A typical sailboat fishing craft consists of a dugout measuring from 10 to 12 meters long, 1.0 to 1.3 meters wide and about a meter deep. It is propelled by a pair of lateen sails consisting of a main and a foresail. It has an open deck like the other two types of fishing crafts. The deck flooring consists of preformed bamboo or wooden slats which are made into removable sections.

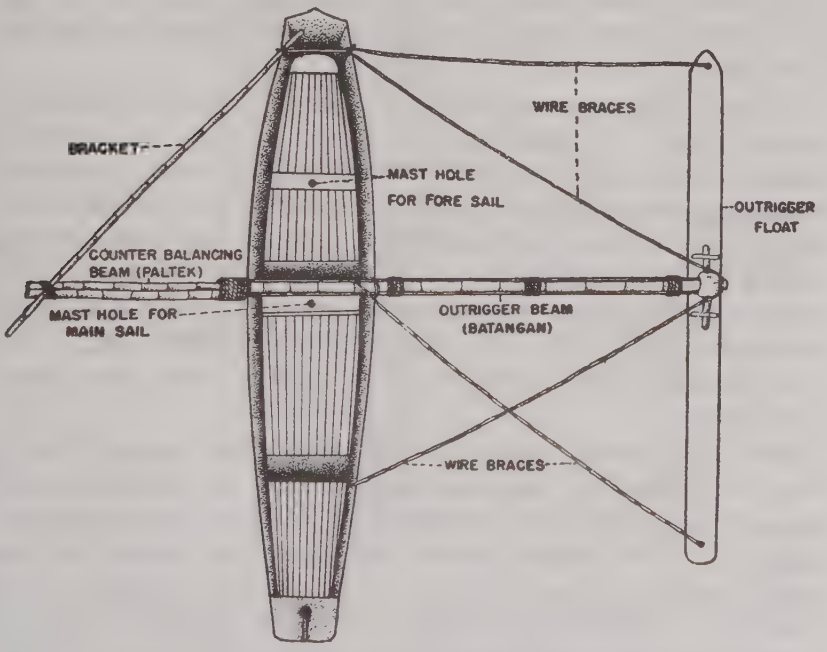


FIG. 2. Deck plan of a typical sailboat fishing craft towing one to two dredge-trawl nets (diagrammatic).

The craft is provided with a single outrigger fixed on the starboard side of the fishing craft. The outrigger consists of a six-meter bamboo (*Bambusa spinosa*) beam (*batangan*) and a wooden float (*palañgoy*). To strengthen it, the beam is braced by a pair of boards (2″ × 6″ × 20′) which are

bolted through the main bamboo beam and seized together by a series of galvanized iron wires or Manila rope seizings. Toward the portside, the beam is extended by a pair of short bamboo beam for counterbalancing purposes (*paltek*). This is supported from the forward bow by a bamboo bracket and mast stays.

The outrigger float is made of a flattened elongate box (6″ × 12″ × 20′) although a number of fishing craft still use the original paired bamboo floats. This box float is completely hollow inside and is constructed from 2-inch tanguile boards. It is thoroughly coated with coal tar to preserve and to keep it watertight. The outrigger float is held in place to the beam by means of a wooden outrigger beam collar and by forward, cross and aft braces made of jointed galvanized iron wire.

At the stern an open socket is provided for the removable rudder tiller. A portable open stove (kerosene or wood) is located aft the fishing craft. Three or four holes (one inch diameter) are drilled along the midcenter of the bottom of the dugout in order to provide entrance of fresh lake water during fishing and for drainage when beaching the fishing craft. The circulation of water in the livewell is crudely provided for by regularly bailing out of the water with a 2-gallon pail.

A complete outfit including two sets of nets costs about 750 pesos.

Motorized fishing craft (*text fig. 3*).—This type of fishing craft is similar in size and general plan of construction to the sailboat, except that the former is provided with an inboard engine and two equal bamboo outriggers and floats on port and starboard sides. Because of the engine installation, the livewell is eliminated and the catch is stored in bamboo baskets. To keep them in fresh condition while in the fishing ground, the fish are stored in alternate layers of either rice straw or banana leaves. Since this type of craft usually operates in the evening, the catches are iced at the landing before shipping them to markets early in the morning.

The engine is installed amidship and is provided with an engine coaming as a protection from the weather. The tiller of the rudder is controlled by an extension lever arm to a wheel immediately behind the engine coaming. To protect the

engine against the rain or splash of lake water, the coaming is covered by either canvas or flat galvanized iron sheet.

A complete outfit including two sets of nets costs about 850 pesos.

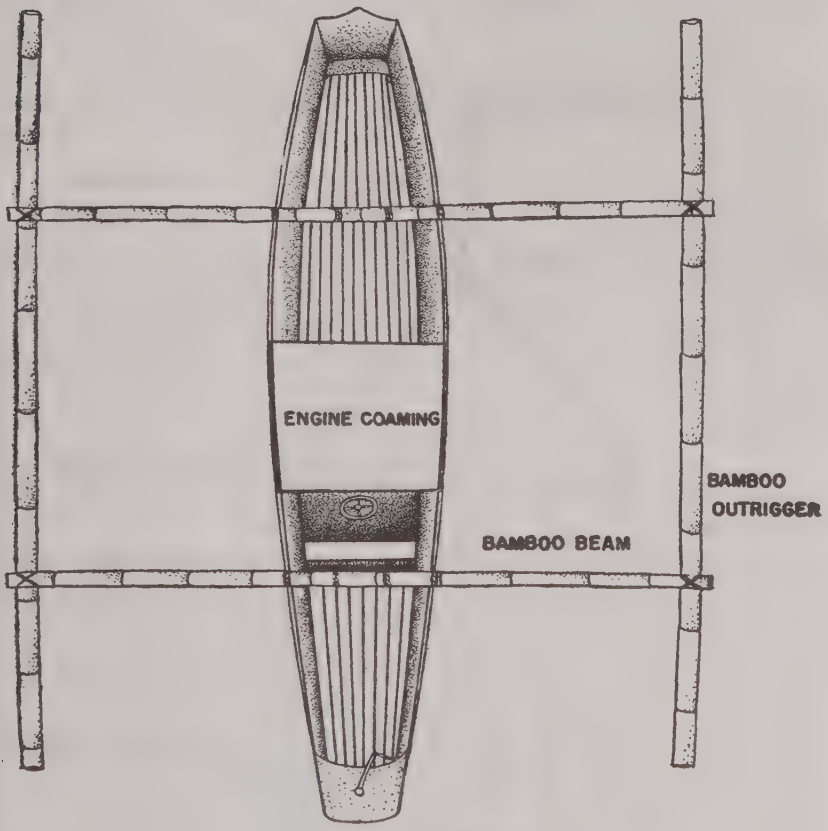


FIG. 3. Deck plan of a motorized fishing craft towing one or two dredge-trawl nets (diagrammatic).

Motorlaunch-towed fishing craft (*text fig. 4*).—The fishing outfit consists of a towing "mother motorlaunch" of about 8 to 15 tons gross, powered with a single diesel engine (70 to 225 horsepower) and one or two towed fishing craft. Ordinarily, one fishing craft towed operates four dredge-trawl nets. The "mother" craft is usually a 30- to 45-foot wooden harbor motorlaunch with a relatively shallow draft of about six feet.

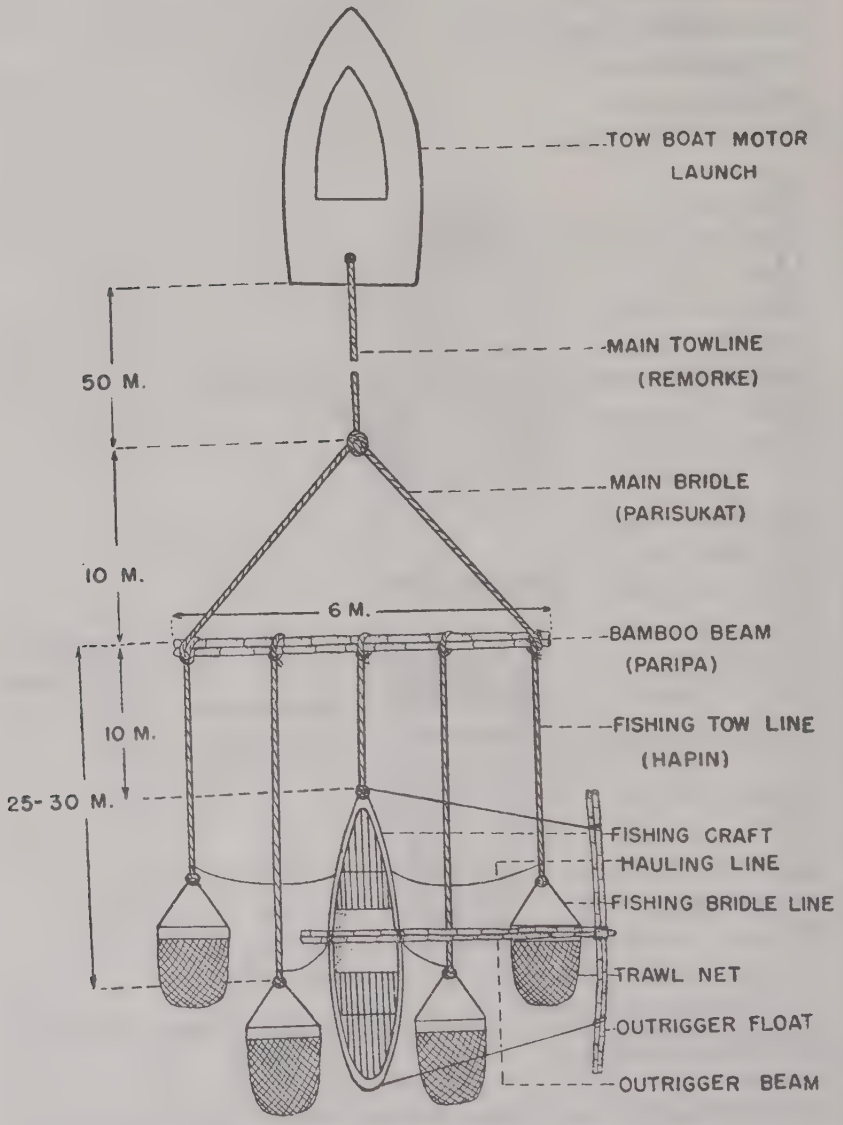


FIG. 4. Motorlaunched-towed fishing craft in operation using four nets (diagrammatic).

The fishing craft proper used is generally bigger than the two types just described. It is about 15 meters long, 1.5 meters wide and about a meter deep. This type of craft has a spacious livewell. It is provided with a starboard outrigger of paired beam and bamboo float. The deck is open with bamboo slat floorings. The midsection of the deck which is

open fore and aft at the bases of the outrigger beam serves as the hatch to the livewell. This uncovered portion of the deck also serves for the bailing out of water while the bottom intake holes of the vessel are open to provide aeration of the livewell. A rudder and an open hand tiller at the stern are also provided for the proper maneuvering of the craft during fishing operation.

A complete outfit including the mother motorlaunch costs from 5,000 pesos to 8,000 pesos,[2] depending upon the tonnage and power of the mother towing vessel.

THE FISHING GEAR

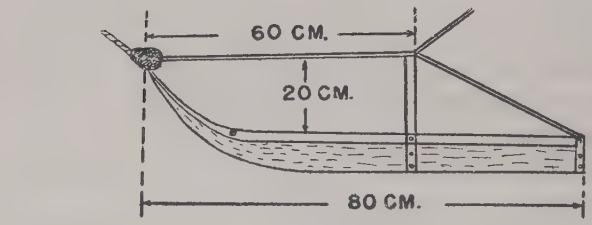
The dredge-trawl fishing gear consists of three main parts, namely, the towline (*remorke*), the dredge-trawl frame (*kaladkad*) and the net proper (*lambat*).

The towlines.—In sailboat and motorized fishing craft, a single towline (*hapin*) is attached to each individual net. It is of Manila rope, ½ to ⅝ inch diameter and about 30 meters long. A two-meter briddle of the same rope connects the towline to the dredge-trawl frame.

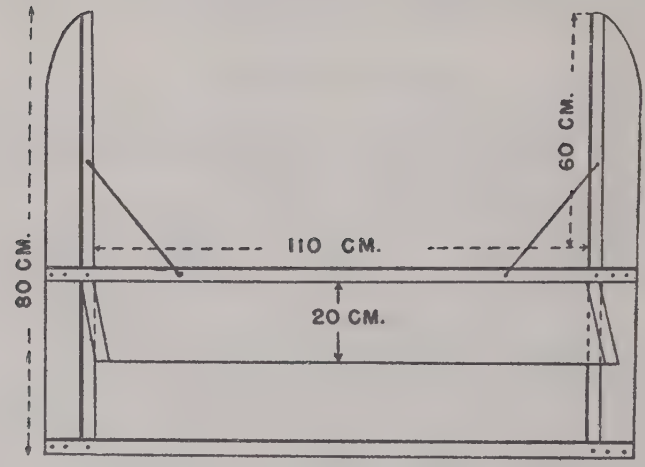
In motorlaunch-towed fishing craft, however, the towline consists of one main line (*remorke*) rigged to the towing motorlaunch and a series of individual fishing towlines (*hapin*) connected to each trawl net. The main towline is made of Manila rope, about 50 meters long and from 1 to 1.5 inches in diameter. This is connected to a 20-meter bridle (*parisukat*) of the same size. The bridle ends are secured to a bamboo beam (*paripa*), consisting of three pieces of a whole bamboo (6 meters long) seized together by G.I. wires or rattan splits. To this beam is secured the fishing craft at the center and the four towlines, each measuring from 25 to 30 meters long and ½ to ⅝ inch in diameter, which are evenly set on the beam. At the junction of each fishing towline and the fishing bridle line, a retrieving line 5 meters long, ½ inch diameter, Manila rope is connected for hauling-in the trawl net.

The dredge-trawl frame (*Plate 4, fig. 1, and text fig. 5*).—In effect the dredge-trawl frame serves as the basic skeletal structure of the gear, like the shrimp pipe trawl, the trawl-heads and sleds of the early original beam trawls used in the early days of trawling in New England and British Columbia (Symonds, 1947). The frame consists of a sledlike device

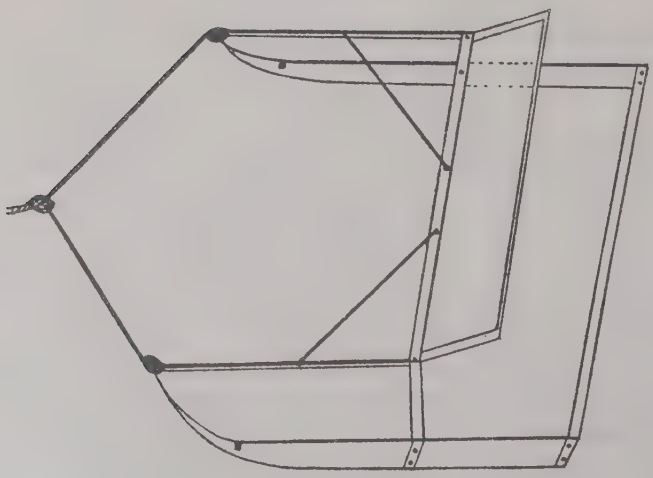
[2] One peso is equivalent to 50 cents U. S. currency.



(A)



(B)



(C)

FIG. 5. Dredge-trawl frame: (A) side view, (B) top view, (C) dorso-lateral view.

made from rivetted iron plates (¼″ by 1″) with two bottom skis or runners. These skis are made either of wood or G.I. iron sheets which prevent the digging-in of the gear on soft mud during operation. To keep the gear from hugging the bottom a horizontal paravane (rectangular wooden board, 20 by 110 centimeters) is rigged in an inclined plane (30° to 45°) on the top of the iron framework. The angle is adjusted by bending upward or downward the iron plate base of the wooden board.

The frontal opening of an average dredge-trawl frame measures 110 centimeters wide and about 20 centimeters in height (text fig. 5*b*). The horizontal length is about 80 centimeters from the tip of the sled-runner to its base. To strengthen the framework two diagonal iron braces, ⅜″ diameter, hold the upper framework. The fore-ends of the skis are connected by a fishing bridle, about 2 meters long, ⅝ inch diameter Manila rope (text fig. 5*c*).

The net proper.—Essentially, the net is similar in general features to that used for the snail dredge. The difference lies only in the size and mesh of the net used—the former being much bigger in size, with larger meshes and heavier netting. The dredge-trawl net and frame when wet weighs about ten kilos, convenient enough for two men to haul-in from the water with the fish catch.

A typical net measures from two to three meters long and about one meter in diameter at the mouth. Normally, a flapper is provided to prevent the escape especially of mudfish (*Ophicephalus striatus*) through the mouth of the net. It is made of a 25-centimeter strip of light netting sewed around the inside lining of the throat and nape of the net, about 30 centimeters from the mouth. The net is made of three parts, namely, the wings (*pakpak*), body (*katawar*) and the cod-end (*supot* or *pusod*).

In effect the wings are not actually a part of the main net. They consist of a barricade of netting rigged on the side of the frame of the skis. This is made of a piece of 6-thread cotton netting, 3-centimeter stretch mesh, which is held by a G.I. iron wire fitted to the shape and size of the side of the trawl frame where it is fixed permanently. As in the modern trawl, these wings prevent the escape of the fish toward the sides; thus increasing the efficiency of the gear.

Text fig. 6*a* shows the diagram of a dredge-trawl net. The net is entirely made of a 3-centimeter stretch mesh, No. 6 thread, seine netting. It is cut from a single piece of netting, 190 meshes long by 150 meshes wide. The shaded sections as indicated in the diagram are cut out. Then the bottom is folded over the top and the following sections are joined together: Sections A to B; E to C–C′; and E′ to D–D′. In folding, the top side is extended 10 meshes beyond the mouth (upper flap) which serves as the square as in the regular trawl nets. The final form of the net when assembled is shown in text fig. 6*b*, resembling a rectangular box. The bottom of the boxlike net becomes the cod-end. The rim of the mouth of the net is provided with a 2″-mesh selvage made of No. 9 thread, and of the same size of mesh as the body of the net.

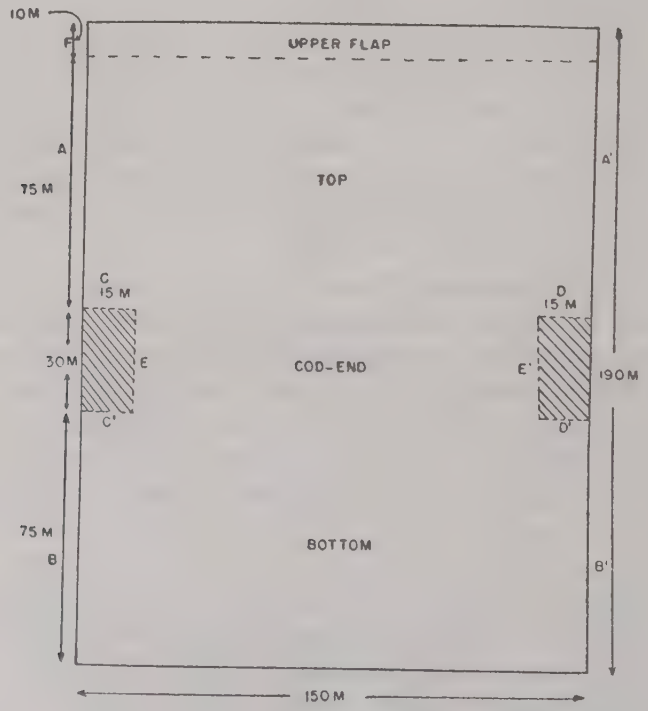


FIG. 6*a*. Cutting diagram of a piece of netting 3-centimeter stretched-measure mesh No. 6 cotton twine 150 x 190 meshes for making a typical fish dredge-trawl net.

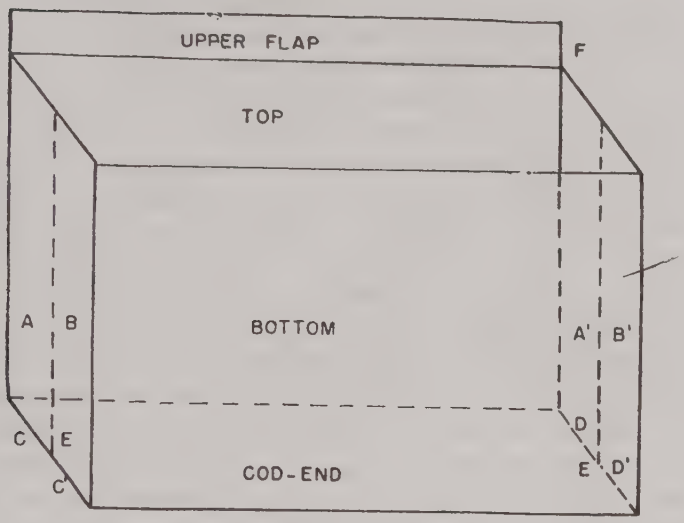


FIG. 6b. The dredge-trawl net after joining sections.

The actual cost of materials and labor needed for the construction of a dredge-trawl gear is as follows:

Frame	₱10.00
Net	10.00
Tow rope	6.00
Total	₱26.00

These dredge trawls are generally made by the fishermen themselves in small village shops located in Bangbang, Pasig and Kalinawan (Plate 3, fig. 1) Binangonan, Rizal Province, and in Gulod, Cabuyao, Laguna Province.

FISHING OPERATIONS

The dredge-trawl net, being light and handy, is suitable for use on board dugout fishing craft without the aid of mechanical deck equipment. The size of trawl nets used is almost the same for the three classes of fishing craft employed in the fishery in Laguna de Bay.

Sailboat fishing craft depend upon steady and moderate winds, which usually occur in the afternoons during the southwest monsoon period (June through August). However, during the northeast and easterly monsoon period (September through March) these winds are more or less steady from sunrise to sunset allowing a full-day fishing operation by the sailboat fishing craft.

The motorized fishing craft usually operate in the evening during the northeast monsoon period returning to port early in the morning to dispose off the catch still in fresh condition, thereby avoiding the use of a livewell.

The motorlaunch-towed fishing craft operate throughout the year except during heavy winds or typhoons. Normally, they leave port between 5:00 and 6:00 o'clock in the morning, arriving between 8:00 and 9:00 in the fishing ground. However, those in the homeport, in Pasig, Rizal, usually leave between 2:00 and 3:00 in the morning, arriving in the fishing ground between 5:00 and 6:00 of the same day. They leave the fishing ground between 12:00 and 1:00 o'clock in the afternoon, arriving Pasig at about 3:00 o'clock, in time for the fresh-fish market. Motorlaunch-towed fishing craft usually clear off the fishing ground before 4:00 in the afternoon in order to allow gill net and set line operators to set out their gear. These gears are retrieved at sunrise of the following day before the dredge trawlers start to operate again.

Shooting the net.—In the fishing ground, after securing all the towlines of each individual net and setting the proper course and trawling speed of the fishing craft, the nets are payed out one after the other on the starboard or port-side, depending upon the position of the towline on the securing beam. Each gear is shot overboard with both hands holding the frame and allowing it to hit flat on the water with the mouth of the frame downward. The towline is held taut until the net stretches out in the water and then the entire towline is released. Dragging then commences (Plate 2, figs. 1–3).

Hauling-in.—In sailboat and motor-propelled fishing craft, the craft is hove-to before the hauling-in operation. The sails are slacked off and/or the engines stopped. Then, the towlines are hauled-in by hands. The dredge-trawl frame is lifted out of the water and placed on deck. The cod-end part of the net is "shaked off" in the water to wash out the mud (Plate 5, fig. 1). The catch is then emptied on the bamboo deck (Plate 5, fig. 2), sorted and released while still alive into the livewell. The small-sized biya and kandule are thrown back into the sea. In motor-launch-towed fishing craft, however, the fishing operation involves a continuous process of alternate shooting and hauling of the four nets. The fishing craft is not hove-to or stopped except in case of a snag or fouling of the gear. However, the hauling-in of the nets is

done by one or two men alternately pulling the towline. A retrieving line, attached to each net facilitates the hauling of the nets on the side of the fishing craft (text fig. 4).

Frequency, speed and duration of drag.—In sailboat and motor-propelled fishing craft, a normal drag takes from 10 to 15 minutes depending upon the abundance of fish and nature of the sea bottom so that in an eight-hour fishing day from 20 to 30 hauls can be made. In motorlaunch-towed fishing craft however, about five to ten minutes is the duration per normal drag, thereby allowing from 70 to 90 hauls in one day. Evidently, more hauls can be made on motorlaunch-towed fishing craft because of its continuous dragging operation. The speed of dragging ranges from one to two miles per hour, the latter rate having been observed in the motorlaunch-towed fishing craft.

Trawl-warp depth ratio.—The trawl-warp depth ratio varies from 6 to 8 times the depth in sailboat and motor-propelled fishing craft. In motorlaunch-towed fishing craft, the ratio is from 8 to 10 times the depth, the payed out towing line ranging from 25 to 35 meters long.

Species caught.—Table 2 shows the list of common marketable species caught by dredge trawlers in Laguna de Bay from June through September, 1950. Among the species of fish

TABLE 2.—*List of common marketable and nonmarketable species taken by dredge trawler in Laguna de Bay (June to September, 1950).*

English name	Tagalog name	Scientific name
Marketable species:		
White goby	Biyang puti	*Glossogobius giurus.*
Sea catfishes	Kandule	*Arius* spp.
Fresh-water theraponid	Ayuñgin	*Therapon plumbeus.*
Murrel	Dalag	*Ophicepalus striatus.*
Fresh-water catfish	Hito	*Clarias batrachus.*
Mullet	Talilong	*Mugil* spp.
Nonmarketable species:		
Prawns	Hipon	*Palaemon lanceifrons.*
Viviparid snail	Papan	*Vivipara angularis.*
Ampularid snail	Kohol	*Ampularia luzonica.*
Clam	Sulid	*Simpsonella subcrassa.*
Clam	Tulya	*Cyrena manillensis.*

caught were the white goby, *biyang puti* (*Glossogobius giurus*); sea catfish, *kandule* (*Arius* spp.); fresh-water theraponid, *ayuñgin* (*Therapon plumbeus*); murrel, *dalag* (*Ophicephalus striatus*); fresh-water catfish, *hito* (*Clarias batrachus*) and white mullets, *talilong* (*Mugil* spp.). Of the species taken, the white goby usually formed the major bulk of the hauls,

the amount varying in different months. From February through September about 65 to 98 per cent of the hauls consisted of biya; 0.5 to 35 per cent, kandule; and up to 14 per cent of dalag (Tables 3, 4 and 5). The theraponid (ayungin) very often formed the major bulk of the trash fish taken in

TABLE 3.—*Analysis by months of catches of sailboat fishing craft in Laguna de Bay towing two nets, Areas 2A, 2B, 4A, and 4B*

Date	Sailboat number	Fishing time	Marketable fish			Total catch	Rate of catch per hour
			Biya	Kandule	Dalag		
1950		*Hrs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*
July	1	6	19	9.0	----	28.0	4.6
	2	7	10	7.0	----	17.0	2.4
	3	6	12	8.0	----	20.0	3.6
	4	5	12	4.8	----	16.8	3.3
	5	5	17	12.0	----	29.0	5.8
	6	7	16	5.0	----	21.0	3.0
	7	5	24	15.0	----	39.0	7.8
	8	5	11	4.0	----	15.0	3.0
Total	----	46	121	64.8	----	185.8	----
Per cent	----	----	65.1	34.9	----	100.0	----
August 2	9	5	16.0	1.5	----	17.5	3.5
	10	5	18.0	3.0	7	28.0	5.6
	11	5	20.0	3.0	23	46.0	9.2
	12	6	30.0	3.0	----	33.0	5.5
	13	5	16.5	4.0	----	20.5	4.1
	14	4	17.5	5.2	----	22.7	5.6
	15	3	14.2	----	----	14.2	4.7
	16	3	22.0	----	----	22.0	7.3
Total	----	36	154.2	19.7	30	203.9	----
Per cent	----	----	75.6	9.7	14.7	100.0	----

Average catch per hour in kilograms: July 4; August, 5.7.
All months combined: 4.8.

TABLE 4.—*Analysis by month of catches of motorized fishing craft using two nets in Laguna de Bay, Areas 2 and 4 (evening operation).*

Date	Fishing unit	Fishing time	Marketable fish		Total catch	Catch per hr. per unit
			Biya	Kandule		
1950		*Hrs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*
September: 13	A	7	8	34	42	6.0
	B	7	6	16	22	3.0
	C	7	6	26	32	4.5
	D	7	7	28	35	5.0
	E	7	3	12	15	2.0
Total	5	35	30	116	146	----
Per cent	----	----	20.6	79.4	100	----

Average catch per hour in kilograms: September, 4.1.

TABLE 5.—*Analysis by months of catches of motorlaunch-towed fishing craft using four nets in Laguna de Bay, Areas 1A, 1B, 2A, and 2B.*[a]

Date	Fishing time	Marketable Catch			Total catch	Rate of catch per hr.
		Biya	Kandule	Ayuñgin		
1950	*Hours*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*
February						
2	7	99.0	2.5		101.5	14.5
3	7	92.0	0.5		92.5	13.2
5	7	93.5		3	96.5	13.8
6	7	88.0			88.0	12.5
8	6	81.5	7.0		88.5	14.8
9	7	102.0	5.5		107.5	15.4
11	7	93.5		28	121.5	17.4
13	7	81.0	4.5		85.5	12.2
15	7	96.0		18	114.0	16.3
16	7	95.5	12.0		107.5	15.4
17	7	93.0			93.0	13.3
Total	76	1,015.0	32.0	49	1,096.0	
Per cent		92.6	2.9	4.5	100.0	
March						
1	7	76.5	5.5		82.0	11.7
2	7	109.5			109.5	15.6
3	7	87.0			87.0	12.4
4	6	78.0			78.0	13.0
6	7	108.5			108.5	15.5
7	7	134.0		8	142.0	20.3
8	7	69.0			69.0	9.9
9	7	101.0			101.0	14.4
16	6	85.0			85.0	14.2
18	7	110.5			110.5	15.8
19	7	82.0			82.0	11.9
Total	75	1,041.0	5.5	8	1,054.5	
Per cent		98.7	0.5	0.8	100.0	
April						
10	7	95	16.0		111	15.9
11	7	97	14.0		111	15.9
12	6	74	11.5		85.5	14.3
13	7	73			73	10.4
14	7	93	3.0		96	13.7
15	7	92			92	13.1
16	7	93			93	13.3
17	7	116			116	16.6
18	7	88.5			88.5	12.6
Total	62	821.5	44.5		866.0	
Per cent		94.9	5.1		100.0	
May						
4	7	73.5	5.0		78.5	11.2
5	7	66.5			66.5	9.5
9	6	76.0			76.0	12.5
10	6	44.5	13.5		58.0	9.7
11	7	69.5	19.5		89.0	12.7
12	7	85.0	13.0		98.0	14.0
13	7	97.5	1.0		98.5	14.1
Total	47	512.5	52.0		564.5	
Per cent		90.8	9.2		100.0	
Grand total	260	3,390.0	134.0	57	3,581.0	
Per cent		94.7	37.0	1.6	100.0	

Average catch per hour in kilograms: February, 14.4; March, 14.06; April, 13.9; May, 12.1. All months combined: 13.62.

[a] Data secured through the courtesy of motorlaunch, *Junior Liner*, a commercial dredge trawler operating in Laguna de Bay during the period.

the haul and the amount was not usually recorded except the few big-sized ones. There was, however, one instance in September, 1950, when the kandule formed 79 per cent of the monthly average haul, exceeding that of biya. The murrel (*Ophicephalus striatus*), fresh-water catfish (*Clarias batrachus*) and mullets (*Mugil* spp.) was also taken as incidental composition of the catch.

There were also included in the haul a number of species of shellfishes which were usually saved by the fishermen for duck feed. These shellfishes consisted of *papan* (*Vivipara angularis*) and *sulib, Simpsonella subcrassa* (Table 2). At times the bigger-sized snails were utilized as food by the fishermen. During the period of abundance of these snails in the lake, the fishing efficiency of the goby dredge trawl was very much reduced owing to the clogging of the cod-end of the net. In every haul the catch consisted mostly of shellfishes with a very small percentage of marketable fishes.

It is very interesting to note here that a lone species of aquatic snake, *duhol, Chersydrus granulatus* (only known member of the genus from the Philippines) is caught in quantities by the dredge-trawlers in Laguna de Bay. From 4 to 8 snakes, ranging in length from one-half to one meter, are taken per haul during the period of observation. A number of this harmless snake are strung together and at the landing their blood is immediately extracted for tanning dredge-trawl nets and scoop nets (*panalok*) used in the fish corral fishery.

Size of catches.—Tables 3, 4, 5 and 6 show the actual catch record of marketable fishes taken by the three kinds of dredge-trawlers observed from February to September, 1950, in Laguna de Bay.

It will be seen that the total catch of sailboat fishing craft per fishing trip of one day ranged from 14 to 46 kilograms of marketable fish consisting of biya, kandule and dalag. The average catch per hour, using two nets, was 4 kilograms for July and 5.7 for August, 1950, with an overall average of 4.8 kilograms. In motorized fishing craft using two nets, the catch per trip a day was almost within the range of those of the sailboat, being 15 to 42 kilograms, and overall average catch per hour of 4.1 kilograms for September, 1950.

With the motorlaunch *M/S Junior Liner* rigged to one fishing craft and towing four nets, the total catch per fishing day ranged from 58 to 142 kilograms from February through May, 1950, with an hourly average of about 14 kilograms for Feb-

ruary, March and April, and 12 kilograms for May (Table 5). With another motorlaunch *M/S Pasigueño* rigged also to one fishing craft and towing four nets the range of catch of marketable fish was from 48 to 93 kilograms per fishing trip of one day with an average catch per hour of 9.5 kilograms for June and July, 1950 (Table 6).

TABLE 6.—*Analysis by months of catches of motorlaunch-towed fishing craft towing 4 nets in Laguna de Bay, Areas 1 and 2* [a]

Date	Fishing time	Marketable catch				Total catch	Rate of catch
		Biya	Kandule	Ayuñgin	Dalag		
1950	*Hours*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*	*Kgs.*
June							
16	7	51.5	8.0	-------	1.0	60.5	8.6
17	6	46.5	23.5	-------	1.5	71.5	11.9
18	7	49.5	12.5	-------	4.5	66.5	9.5
19	7	54.0	29.0	-------	2.5	85.5	12.2
21	7	36.5	6.0	-------	5.5	48.0	6.9
22	7	42.0	13.0	-------	3.0	58.0	8.3
23	6	41.1	4.5	-------	8.0	53.5	8.9
24	7	46.0	1.5	-------	2.0	49.5	7.1
26	8	48.0	43.0	-------	2.0	93.0	11.6
Total	62	415.0	141.0	-------	30.0	586.0	----------
Per cent	-------	70.8	24.1	-------	5.1	-------	----------
July							
3	7	57.5	34.0	-------	1	92.5	13.2
4	7	46.5	28.0	-------	3	77.5	11.1
5	7	30.0	18.0	-------	-------	48.0	6.9
7	7	25.0	21.0	7.0	-------	53.0	7.6
8	7	56.0	13.5	-------	-------	69.5	9.9
Totals	35	215.0	114.5	7.0	4	340.5	----------
Grand total	97	630.0	255.5	7.0	34	926.5	----------
Per cent	-------	68.0	27.6	0.7	3.7	-------	----------

Average catch per hour in kilograms: June, 9.5; July, 9.7; all months combined, 9.6 kilograms.

[a] Data secured through the courtesy of motorlaunch *Pasigueño*, a commercial dredge trawler operating in Laguna de Bay during the period.

It appears from the foregoing rate of catch of marketable fish that the motorlaunch-towed fishing craft landed from two to four times as much as that of the sailboat and motorized fishing craft. This is attributed to the fact that the former towed twice the number of nets, and in actual fishing operation, at least two or three trawl nets fish continuously while one or two are being hauled-in simultaneously.

Size composition of the catch by species.—Tables 7, 8 and 9 and text figs. 7 to 10 show the size composition of samples taken from the commercial catches of sailboat trawlers by species from June to August, 1950, inclusive. It will be seen that the size (body length) composition of biya taken ranges from 60 to 280 millimeters long with the mode at 124 milli-

TABLE 7.—*Length frequency distribution by month of samples of biya (Glossogobius giurus) taken by sailboat fishing craft in Laguna de Bay.*

Standard length	Biya (*Glossogobius giurus*)	
	June, 1950	July, 1950
mm.		
50— 59		
60— 69	1	
70— 79	1	
80— 89	3	1
90— 99	8	17
100—109	20	16
100—119	31	92
120—129	71	88
130—139	54	60
140—149	39	50
150—159	36	34
160—169	23	24
170—179	12	25
180—189	14	15
190—199	7	12
200—209	3	8
210—219	10	3
220—229	3	3
230—239	1	1
240—249	4	1
250—259		1
260—269		2
270—279		1
280—289	2	
TOTAL	343	504

TABLE 8.—*Length frequency distribution by month of samples of kandule (Arius spp.) taken by sailboat fishing craft in Laguna de Bay.*

Fork length	Kandule (*Arius* spp.)	
	June, 1950	July, 1950
mm.		
41— 45	2	
46— 50	1	
51— 55		
56— 60	12	
61— 65	10	
66— 70	10	
71— 75	1	
76— 80	4	
81— 85	2	
86— 90	2	
91— 95	2	
96—100	1	
101—105		
106—110		
111—115		4
116—120		4
121—125		6
126—130		10
131—135		19
136—140		9
141—145		14
146—150		12
151—155		2
156—160		5
161—165		5
166—170		2
171—175		0
176—180		0
181—185		0
186—190		2
191—195		4
196—200		1
201—205		2
Total	47	101

TABLE 9.—*Length frequency distribution by month of samples of ayuñgin (Therapon plumbeus) taken by sailboat fishing craft in Laguna de Bay.*

Standard length	Ayuñgin (*Therapon plumbeus*)	
	June, 1950	July-August, 1950
mm.		
31– 35	----------	1
36– 40	----------	1
41– 45	1	1
46– 50	2	2
51– 55	7	1
56– 60	33	6
61– 65	86	23
66– 70	71	15
71– 75	59	10
76– 80	26	9
81– 85	10	1
86– 90	3	----------
91– 95	1	----------
96–100	1	----------
101–105	----------	2
TOTAL	310	72

meters in June, 1950 (text fig. 7). In July of the same year, the size range of the samples taken was almost the same, but the mode was 114 millimeters, an indication that more of the lower size groups were taken during this month.

With the kandule, the size (fork length) composition of fish taken ranges from 33 to 98 millimeters for June, 1950, with the mode at 58 millimeters, while for July of same year the size ranges from 113 to 203 millimeters long with the mode at 133 millimeters (text figs. 8 and 9). It appears that more of the younger groups were taken during June in the fishery just at the close of the breeding season of the fish.

With the ayuñgin, the size (body length) composition ranges from 33 to 98 millimeters with the mode at 63 millimeters long. For July and August, 1950, the size ranges from 33 to 103 millimeters long, with the mode at 63 millimeters (text fig. 10). It is probable that more of the younger groups would have been measured in the sample were they not thrown back into the water during the fishing operation for being not readily marketable.

Sorting.—The catch (Plate 5, fig. 2) of the dredge trawl consists of an assortment of several species of varying sizes. As soon as the catch is landed on deck the undersized *biya*, *ayuñgin* and *kandule* are thrown back into the water while still alive. The murrels (dalag) are placed in a separate bag net (*barcelona*); the kandule, biya, and bigger ayuñgin in

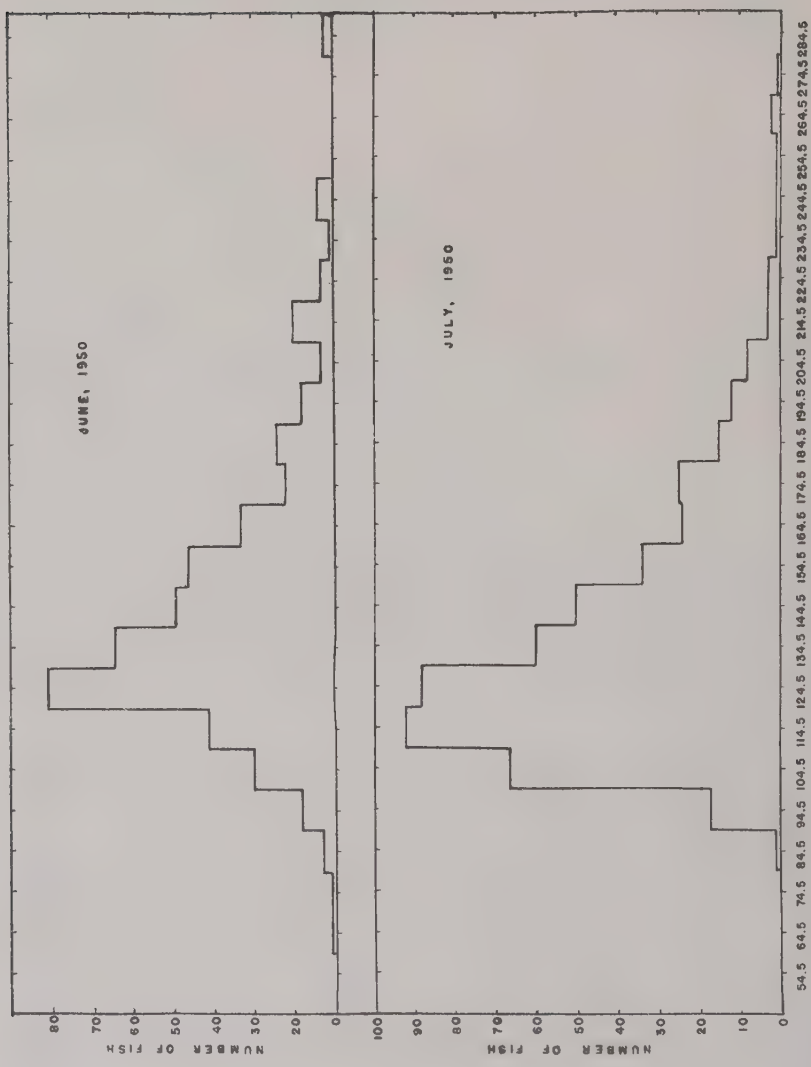


FIG. 7. Length frequencies of samples of biya (*Glossogobius giuris*) taken by sailboat fishing in Laguna de Bay (based on the figures in Table 7).

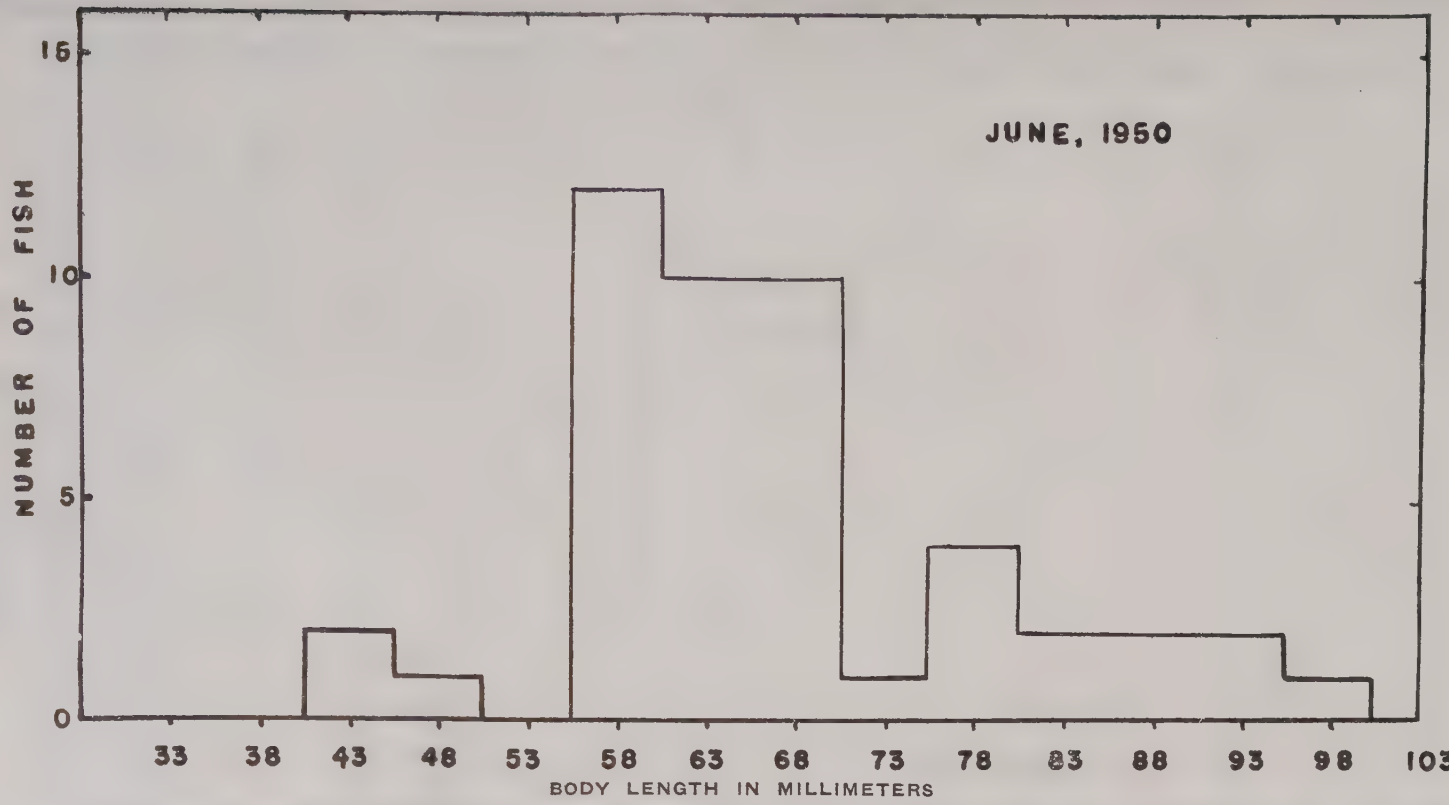


FIG. 8. Length frequencies of samples of kandule (*Arius* sp.) taken by sailboat fishing craft in Laguna de Bay, June, 1950 (based on figures in Table 8).

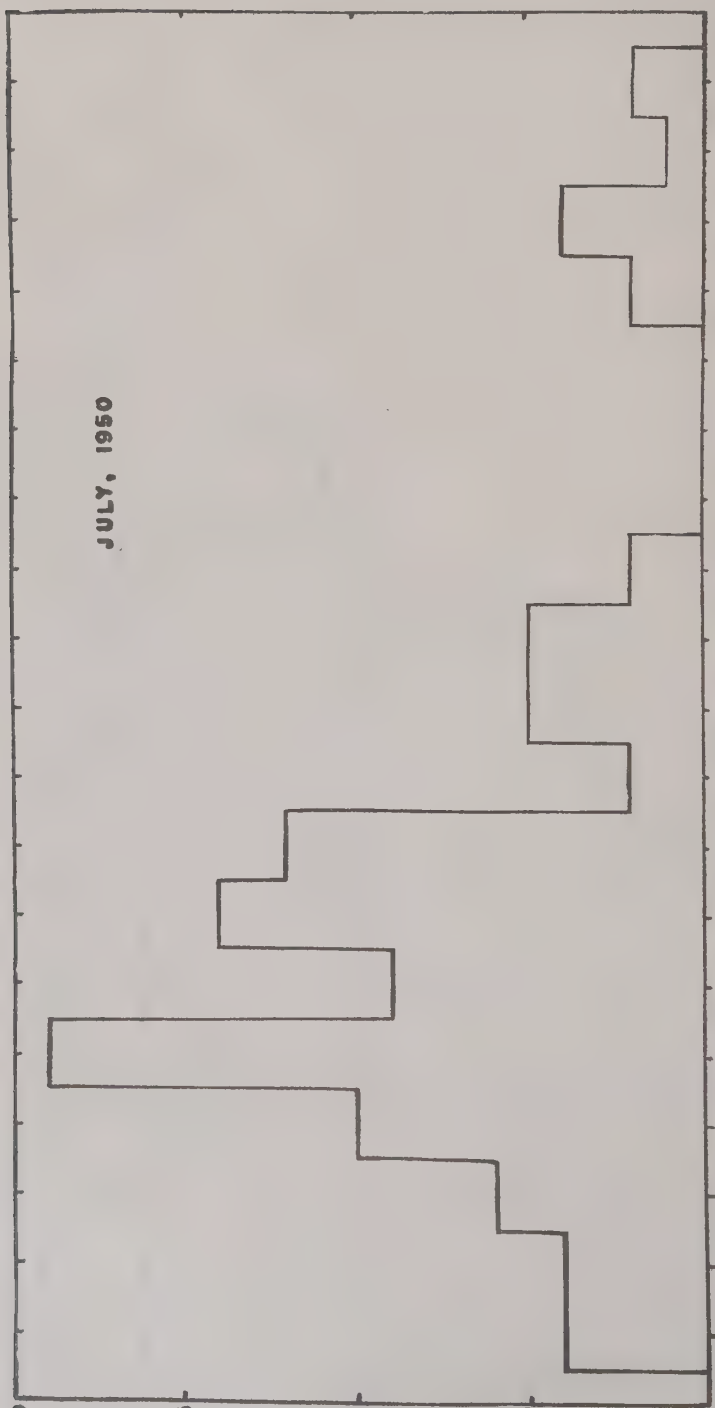


FIG. 9. Length frequencies of samples of kandule (*Arius* sp.) taken by sailboat fishing craft in Laguna de Bay, June, 1950 (basedon figures in Table 8).

separate bamboo containers packed in layers with either banana leaves or some aquatic plants. On board motorlaunch-towed fishing craft, when the hold serves as a livewell, all the selected sizes of the commercial species taken are kept alive. The larger ayungin are sorted and placed in bamboo baskets (*kaing*), and later salted and dried by the fishermen.

No icing of the catch is done aboard the fishing craft except at the fish landing when necessary.

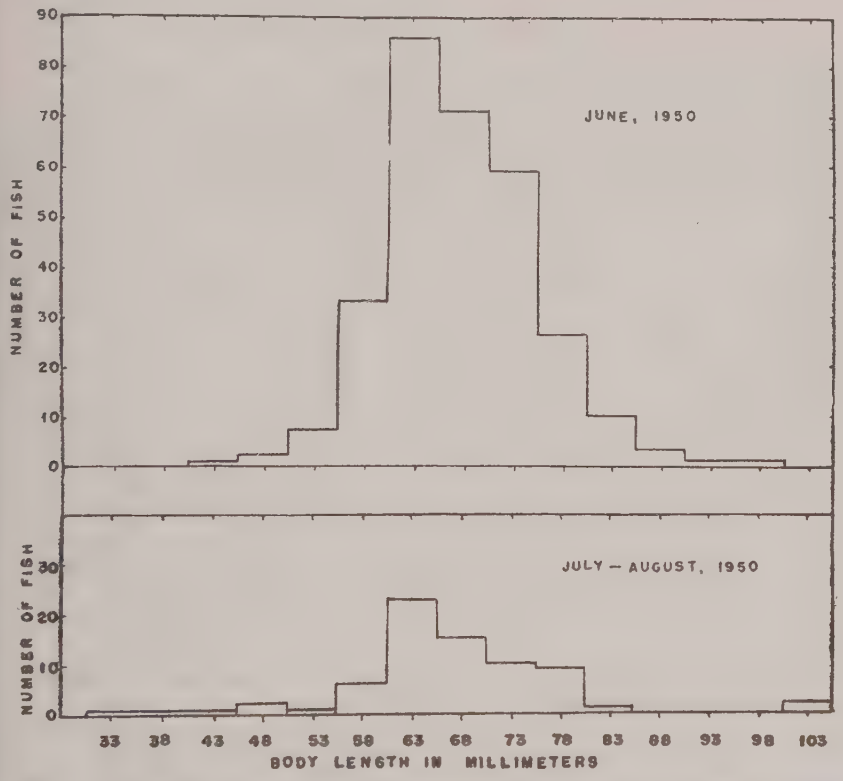

JUNE, 1950
JULY – AUGUST, 1950
NUMBER OF FISH
NUMBER OF FISH
BODY LENGTH IN MILLIMETERS
33 38 43 48 53 58 63 68 73 78 83 88 93 98 103

FIG. 10. Length frequencies of samples of ayungin (*Therapon plumbeus*) taken by sailboat fishing craft in Laguna de Bay (based on figures in Table 9).

SIZE COMPOSITION OF BIYA TAKEN IN RELATION TO THE MESH OF COD-END OF NETS USED

In order to determine the possible destructive effect of the dredge-trawl gear on the biya fishery, a comparative analysis of the size composition of the catch of the three different sizes of mesh of cod-ends of nets used by sailboat fishing craft was undertaken. Tables 10 and 11 show the results for June and

July, 1950, for the three cases. A total of 1,106 individuals taken by a 2.5-centimeter mesh cod-end were measured, 504 for 3.0-centimeter mesh, and 197 for 3.5-centimeter mesh stretched.

TABLE 10.—*Length frequency distribution of biya taken by sailboat fishing craft for June and July, 1950 in Laguna de Bay, by size of cod-end mesh of dredge-trawl net.*

Standard length	Cod-end mesh (stretched)			
	2.5 cm.	3.0 cm.	3.5 cm.	Combined
mm.				
50– 59	3			3
60– 69	21			21
70– 79	62			62
80– 89	56	1		57
90– 99	89	17		106
100–109	139	66	4	209
110–119	182	92	11	285
120–129	194	88	34	316
130–139	134	60	36	230
140–149	91	50	25	166
150–159	72	34	24	130
160–169	26	24	16	66
170–179	18	25	10	53
180–189	6	15	11	32
190–199	5	12	2	19
200–209	6	8	2	16
210–219	5	3	9	17
220–229	1	3	3	7
230–239	4	1	1	6
240–249	1	1	2	4
250–259	1	1		2
260–269		2		2
270–279		1		2
280–289			2	2
Total	1,116	504	192	1,812

TABLE 11.—*Percentage composition of immature and mature biya taken by sailboat fishing craft in June and July, 1950, by size of mesh of cod-end of net used.*

Cod-end mesh (stretched)	Immature fish		Mature fish		Total
cm.	*Number*	*Per cent*	*Number*	*Per cent*	
2.5	746	66.84	370	33.16	1,116
3.0	264	52.38	240	47.62	504
3.5	49	25.52	143	74.48	192

Using 125 millimeters [3] as the mean standard length at sexual maturity of biya, the percentage composition of immature and mature fish taken in the commercial haul was determined. From this analysis of 1,812 specimens examined, it was found that 66 per cent of the samples taken by 2.5 cm. cod-end mesh were immature; 52 per cent by 3.0 cm. mesh; and 26 per cent

[3] Mean size at sexual maturity was determined in a separate study undertaken by the authors during the same period of observations.

by the 3.5 cm. mesh. Conversely, an increased percentage of mature fish becomes evident as the size of the cod-end mesh increases (text fig. 11). The larger meshes appeared to have provided sufficient "escapement" of immature fish to reach maturity in order to spawn and replace the stock. The use of larger meshes in the trawl fishery in the North Atlantic and the West Coast of America is an accepted practice as established by regulatory measures in protecting the immature groups and allowing the fish to spawn even once before they are caught.

DISPOSAL OF THE CATCH

The catch of the dredge-trawlers in Laguna de Bay are usually disposed in three important landings; namely, Pasig and Binangonan, Rizal Province, and Biñan, Laguna. Binangonan and Biñan are the homeports of most sailing boat and motorized fishing craft (Plate 1, figs. 1–2) and Pasig for most motorlaunch, towed fishing craft.

The catches of motorized and sailboat fishing craft are usually marketed in the morning. At the landing, the fish are mostly kept alive in the livewell of the fishing vessel or in live-boxes or crates (bamboo or G.I. wire netting) placed in the lake. The bigger-sized dead fishes upon landing are iced in bamboo baskets while the small-sized biya are kippered, salted and dried (Plate 4, fig. 2). The ayung̃in are soaked in brine overnight, dried under the sun and staked in pieces of bamboo sticks known locally as *"karingkaring."* The kippered biya are also staked in pieces of bamboo sticks. Both are sold by the hundreds of stakes.

The catches of the motorlaunch-towed fishing craft are sold direct to the fresh fish market in Pasig, Rizal, the fish being kept alive in the livewell during the entire fishing trip. Most of the fish landed in Binangonan and Cardona, Rizal, are transported by trucks to Manila markets early in the morning. In Biñan, Laguna, the fish are transported by trucks to Batangas, Cavite and Laguna town markets.

The wholesale price of the large marketable fresh biya per kilo ranged from 60 to 80 centavos,[4] the small biya, 20 to 40 centavos. At the landing dead biya are usually sold half the price of the live ones. The kandule is considered a delicacy in Laguna and Rizal Provinces and the wholesale price usually ranges from 90 centavos to one peso per kilo.

[4] One centavo is equivalent to one-half cent U. S. currency.

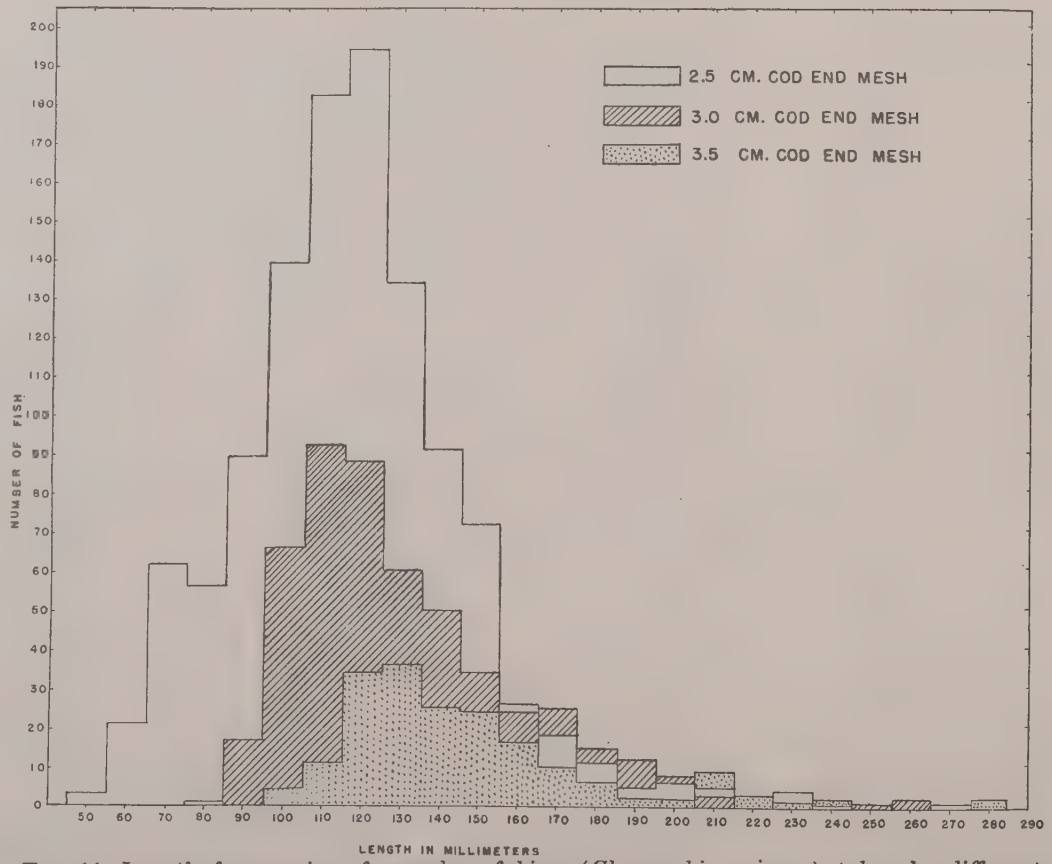


FIG. 11. Length frequencies of samples of biya (*Glossogobius giurus*) taken by different sizes of mesh of cod-end used by sailboat fishing craft in Laguna de Bay, [illegible] Table 10)

Tanning of trawl nets.—Trawl nets are usually tanned every week. The nets are first tanned in a solution of macerated bark of *bakawan* (*Rhizophora candelaria* DC.) and later treated with the blood extracted from an aquatic snake, *duhol,* taken in the hauls. The blood treated nets are dried under the sun and steamed in order to coagulate the blood proteins completely. The net is now ready for use after this treatment.

SUMMARY

A comparatively new fishery was developed and established in Laguna de Bay with the introduction of an indigenous goby dredge-trawl gear, locally called *"kaladkad pangbiya",* used in the catching of demersal species.

As to mode of propulsion, the fishing craft are classified in three categories; namely, sailboat, motorized and motorlaunch-towed boats. The fishing craft proper consists of the conventional dugout measuring from 12 to 14 meters long, 1.0 to 1.3 meters wide and about a meter deep; about one ton gross capacity.

The rigging of the fishing craft and gear, the fishing operation, handling and marketing of the catch are fully described.

The rate of catch per hour varies in the three kinds of fishing craft used, 4.5 kilograms for sailboat and motorized craft and 12.0 kilograms for motorlaunch-towed vessel. The rate of catch by depth and by area was not ascertained in this study.

The dredge-trawl catches consist of six species of fish represented by six families, five species of shellfishes and a lone species of aquatic snake, *Chersydrus granulatus.* The biya (*Glossogobius giurus*) formed from 65 to 95 per cent of the haul, followed by kandule (*Arius* spp.) and dalag (*Ophicephalus striatus*). The ayuñgin (*Therapon plumbeus*) is generally considered a trash fish in the catch.

The composition of the catch by species was found to range from 54 to 280 millimeters (body length) for biya; 33 to 203 millimeters (fork length) for kandule, and 33 to 98 millimeters (body length) for ayuñgin.

The percentage composition of immature and mature biya taken varies with the different cod-end mesh of nets used. For 2.5-centimeter mesh, 66 per cent was found to be immature; for 3-centimeter mesh, 52 per cent; and for 3.5-centimeter mesh, 24 per cent.

The dredge-trawl nets are tanned with a combination of extracted blood of fresh-water snake and of *bakawan* (*Rhizophora candelaria*) cultch.

LITERATURE CITED

ARRIOLA, F. J., and D. K. VILLALUZ. Snail fishing and duck raising in Laguna de Bay, Luzon. Phil. Jour. Sci. 69 (1939) 173–190, figs. 1–4.

MANE, A. M. A preliminary study of the life history and habits of kandule (*Arius* spp.) in Laguna de Bay. Phil. Agric. 18 (1929) 81–106; ch. 1–7; figs. 1–110.

MANE, A. M. Spawning and feeding habits of *ayungin*, *mosopristes plumbea* (Kner), a common theraponid fish in Laguna de Bay. Phil. Agric. 23 (1934) 502–511; ch. 1–3; figs. 1–2.

SYMONDS, R. F. The development of beam trawling in the North Atlantic Quincy, Mass. New England Soc. Naval Architects and Marine Eng. (1947) January Meeting (pub. rept.) pt. 1; 1–23.

ILLUSTRATIONS

PLATE 1

FIG. 1. Sailboat fishing craft anchored or beached at Kalinawan, Binangonan, Rizal Province.
2. Barrio Kalinawan, Binangonan, Rizal, a home port of sailboat and motorized fishing craft in Laguna de Bay.

PLATE 2

FIG. 1. Sailboat fishing craft in operation on the eastern portion of Laguna de Bay.
2. Sailboat fishing craft towing two nets in Laguna de Bay.
3. A typical sailboat fishing craft in actual fishing operation in Laguna de Bay.

PLATE 3

FIG. 1. A dredge-trawl frame maker, Kalinawan, Binangonan, Rizal.
2. Finished dredge-trawl frames, Kalinawan, Binangonan, Rizal.

PLATE 4

FIG. 1. A typical dredge-trawl net laid out with its coiled tow line.
2. Kippered biya (*Glossogobius giurus*) taken by dredge-trawler strung in pointed bamboo sticks being dried under the sun, Binangonan, Rizal.

PLATE 5

FIG. 1. Hauling-in a dredge-trawl net on a sailboat fishing dugout. Note fish at the cod-end.
2. A typical haul of fish spread on deck of a sailboat fishing craft. Note the catch of fish and snails on the side of the deck, Laguna de Bay.

TEXT FIGURES

FIG. 1. Map of Laguna de Bay showing divisions of reference areas.
2. Deck plan of a typical sailboat fishing craft towing one to two dredge-trawl nets (diagrammatic).
3. Deck plan of a typical motorized fishing craft towing one to two dredge-trawl nets (diagrammatic).
4. Motorlaunch-towed fishing craft in operation towing four dredge-trawl nets (diagrammatic).
5. Dredge-trawl frame (A) side view, (B) top view and (C) dorso-lateral view (diagrammatic).
6. *a*, Cutting diagram of a piece of netting 3-centimeter stretched-measure mesh No. 6 seine twine, 150 × 190 meshes, for making typical fish dredge-trawl net. *b*, The dredge-trawl net after joining the sections shown in figure 6. Joining is done by meshing the various parts together. To form the dredge-trawl net fold-over the top section over the bottom section so that A join with B and A′ with B′ to a point 10 M below the top edge to form the upper flap. Likewise C and C′ is joined with E and D and D′ with E′.

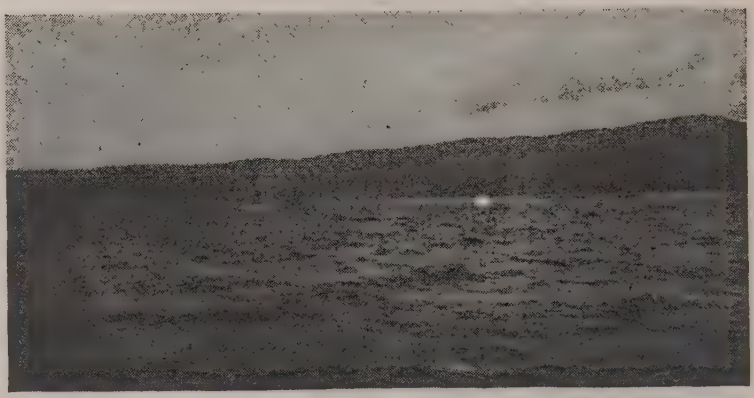
ILLUSTRATIONS

7. Length frequencies of samples of biy. (*Glossogobius giurus*) taken by sailboat fishing craft in Laguna de Bay (based on the figures in Table 1).
8. Length frequencies of samples of kandule (*Arius sp.*) taken by sailboat fishing craft in Laguna de Bay, June, 1950 (based on figures in Table 2).
9. Length frequencies of samples of kandule (*Arius sp.*) taken by sailboat fishing craft in Laguna de Bay, July, 1950 (based on figures in Table 2).
10. Length frequencies of samples of ayuñgin (*Therapon plumbeus*) taken by sailboat fishing craft in Laguna de Bay (based on figures in Table 3).
11. Length frequencies of samples of biya (*Glossogobius giurus*) taken by different sizes of mesh of cod-end used by sailboat fishing craft in Laguna de Bay, June and July, 1950 (based on figures in Table 10).

1

2

PLATE 1



1

2

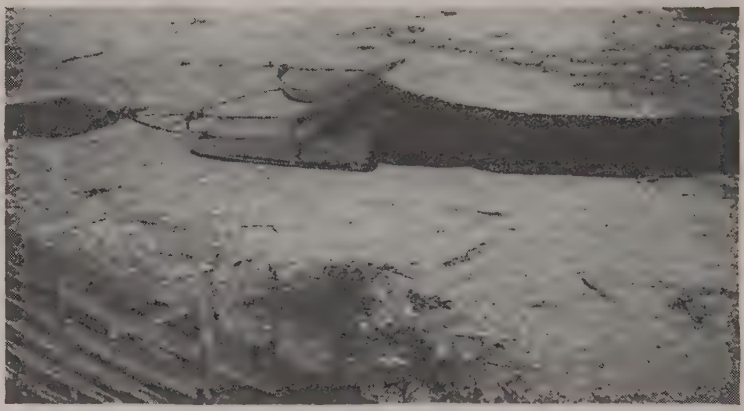
3

PLATE 2

1

2

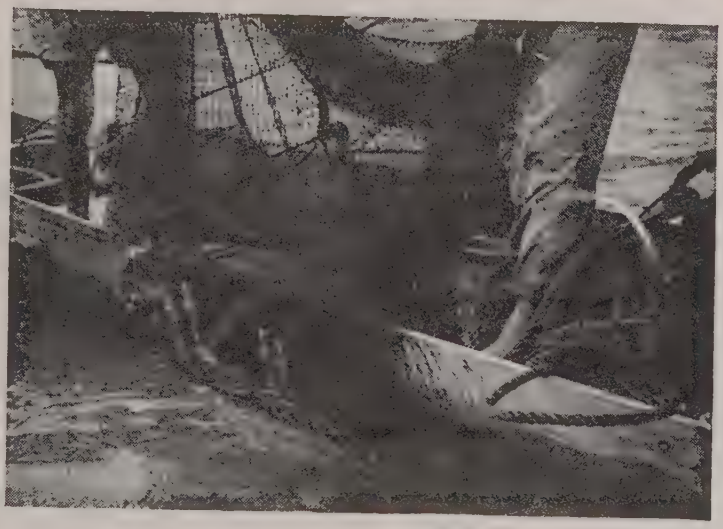
PLATE 3



1

2

PLATE 4



1

2

PLATE 5

AN OUTLOOK OF THE PHILIPPINE TUNA FISHERIES [1]

By D. V. Villadolid, Teodoro G. Megia and Inocencio A. Ronquillo

Of the Bureau of Fisheries, Manila, Philippines

The commanding position of the tunas in the world's fisheries attracts an increasing attention to the exploration of tropical waters. Lying within this belt of warm waters, the Philippine seas naturally constitute an integral unit of the great tuna fisheries of the Asiatic quadrant of the Pacific, which in the past had produced 78 per cent of the Pacific tonnage. Realizing this potentiality of Philippine waters for tuna exploitation ventures, the Philippine Bureau of Fisheries plans to launch a large scale investigation of the areas that bear promise of excellent yields in the light of our present knowledge of the oceanography of Philippine waters. Such areas as southeastern Mindanao, where the Pacific Equatorial Current begins, and northeastern Luzon which is known to be within the path of tuna migration will be intensively investigated. For this purpose, the 187-ton *M/S Fisheries* of the Philippine Bureau of Fisheries will be used.

Aside from the tuna exploration work carried out by the Japanese in scattered areas in the Philippines, there has been no systematic survey undertaken within our territorial waters for exploiting the tunas, more particularly the yellowfin, which abounds in our high seas. The Philippine Fishery Program of the United States Fish and Wildlife Service made several attempts using the well-known Japanese longline. Although the results obtained were not altogether encouraging, undoubtedly on account of the paucity of factual oceanographic data, the exploratory work has led to an appreciation of the importance of collecting oceanographic information and correlating it with the tuna catch. This scheme of making hydrographic observations hand-in-hand with tuna fishing operations has been widely practiced by the Japanese, who have developed the tuna long-lining technique to a high degree of efficiency.

[1] Contribution of the Philippine Delegation to the Third Meeting of the I.P.F.C. at Madras, February 1–16, 1951.

Confident of the success of this type of subsurface fishing for tunas, the Pacific Fishing Development Company of the Philippines recently acquired two tuna boats of about 50 tons capacity each. Equipped with the long-line and manned by experienced Taiwanese fishermen, the *M/V Nelly* and the *M/V Dinia* have fished several areas, principally the Sulu and Celebes Seas. Although their catch records do not show figures close to the reported Japanese catch ratio of 7.0 for Sulu Sea and 9.5 for Celebes Sea, the results show promise of economic possibility. A break-down of the catch of the *M/V Nelly* in two of its trips is found in the accompanying tables.

TABLE 1.—*Summary of catch: First trip.*

Date	Fishing grounds (sea)	Number of fishing hours	Number and weight of catch			Total number daily catch
			Tuna	Shark	Swordfish	
1950 August						
14	Sulu Sea Central Part	18.5	24 1,500 kg.		2 150 kg.	26 1,650 kg.
15	do	18.5	24 1,470 kg.	7 200 kg.	6 1,010 kg.	37 2,683 kg.
16	Sulu Sea Southern Part	18.0	17 1,800 kg.	12 1,955 kg.		29 3,755 kg.
17	do	18.8	6 420 kg.	7 850 kg.	2 270 kg.	15 1,540 kg.
19	Sulu Sea Eastern Part	17.8	9 450 kg.		3 30 kg.	12 480 kg.
20	Sulu Sea Northeastern Part	17.5	18 900 kg.	2 200 kg.	2 650 kg.	22 1,750 kg.
21	do	17.8	12 600 kg.	2 120 kg.	1 40 kg.	15 760 kg.
22	do	17.0	13 780 kg.	3 150 kg.	4 200 kg.	20 1,130 kg.
		143.9 hours or 6 days	123 7,920 kg.	33 3,475 kg.	20 2,550 kg.	176 13,945 kg.

Total (in tons), 13,945 (long).

TABLE 2.—*Summary of catch:*[a] *Second trip*

Date	Tuna	Swordfish	Sail fish	Sharks	Barracuda
9-22-50	10	2	0	4	
9-24-50	6	3	0	5	
9-25-50	8	0	1	1	
9-27-50	3	1	0	1	
9-28-50	1	2	1	1	
9-30-50	7	4	3	4	
10-1-50	6	1	5	3	
10-6-50	3	3	0	2	2

[a] The smallest tuna weighed 45 kilos, while the sailfish averaged 100 kilos each.

The data reveal much interesting information basic to the understanding of the causes underlying the success or failure of tuna fishing in those areas. The yellowfin tuna dominated the catch. Even at subsurface levels, there was evidence of predation by sharks which are normally surface-feeders. In

August and September when the warm waters from the lower latitudes must have reached their northernmost displacement, tunas were still found in the two fishing grounds.

The above information demonstrates the value of a knowledge of certain oceanographic factors in tuna-long-line operations. Of these factors, temperature, current drift and set, transparency and bottom topography are the most important in the light of the Japanese observations gathered in the tropical regions of the Pacific. Based on the Japanese investigations, the best catches were made in waters the temperature of which from the surface to a depth of 100 meters was over 20° C., transparency between 25 to 35 meters and current drift between 0.5 and 1.5 knots.

EQUIPMENT AND METHODS USED IN OCEANOGRAPHIC INVESTIGATIONS IN THE PHILIPPINES [1]

By Teodoro G. Megia and Alfonso R. Sebastian

Of the Bureau of Fisheries, Manila, Philippines

ABSTRACT

In the Philippines, oceanographic investigations are carried out with the equipment and instruments turned over to the Bureau of Fisheries by the American Government, following the termination in 1950 of the Philippine Fishery Program of the United States Fish and Wildlife Service. The methods and chemical procedures being followed are patterned after those in practice at the former Oceanographic Laboratories of the University of Washington, U. S. A. Slight modifications in carrying out the chemical determinations have been adopted to suit local needs. Nomenclature and units are in accordance with international standards.

The importance of conducting cooperative oceanographic investigations in the Indo-Pacific region emphasizes the need of using uniformly reliable and accurate equipment and instruments, standardizing methods, nomenclature, and units. The information herein offered is intended to stimulate interest in filling this need, and invite complementary information from different countries of the region.

The equipment and instruments now in use by the Philippine Bureau of Fisheries are not the latest in design and construction, nor are they complete to enable us to carry out a comprehensive research program. Our methods and procedures, on the other hand, are an adaptation of the standardized system followed by the defunct Philippine Fishery Program of the United States Fish and Wildlife Service.

EQUIPMENT

Boat.—The M/V *David Starr Jordan* of the Bureau of Fisheries was acquired in May, 1950, as part of the equipment and supplies turned over to the Philippines after the termination of the Philippine Fishery Program. Completely rebuilt by the Grandy Boat Building Company of Seattle, Washington, the boat was outfitted for otter trawling operation in Philippine

[1] Contribution of the Philippine Delegation to the Fourth Meeting of the I.P.F.C. at Quezon City, Philippines, October 23 to November 7, 1952.

waters by the United States Fish and Wildlife Service. Although its winch is not suitable for working high-speed oceanographic gear, the boat is stable, seaworthy and highly maneuverable. An after-deck affords ample space for the work-table used in the shipboard chemical work. The walls of this table serve as racks for a battery of 15 water bottles.

The principal dimensions of the vessel are: overall length, 16.2 meters; length at water line, 14.6 meters; breadth, 4.0 meters; and draft, 2.0 meters. The 30-ton vessel is driven by a 135-horsepower Murphy diesel engine, giving a cruising speed of six knots.

The sampling gear is made up of the starboard drum of the drag winch which can pay out the $\frac{5}{32}$-inch hydrographic wire at the rate of two meters per second, and retrieve it at about one-sixth that rate. From the starboard drum the wire passes through a sheave fastened to the seaside of the gunwale, then to the meter wheel, and thence into the water. Shocks due to uneven motions of both boat and sea are absorbed by the accumulator which is suspended above the meter wheel. The accumulator is in turn hung from the free end of the davit used as boom. This sampling set-up, though not in accordance with standard practice, has met our requirements even under adverse sea conditions.

Thermometers.—The deep-sea reversing thermometers being used are a part of the 497 Japanese thermometers which were turned over to the Philippines as part of the reparations of World War II. Fifty-seven thermometers from this stock were used by the Philippine Fishery Program, and these are the same instruments being used by the Philippine Bureau of Fisheries at the present time. They were manufactured by the Watanabe Keiki Manufacturing Co., Tokyo, Japan.

These thermometers bore no calibration certificates; hence, the corrected temperatures based on headings taken from them are only relative. Personnel of the Philippine Fishery Program had calibrated these instruments against two Richter and Wiese thermometers, but the certificates of these two reference thermometers also are not available at present.

The performance of these Japanese-made thermometers has been, as a whole, thoroughly satisfactory. A comparison of the *Baird* temperatures with those of the *Snellius* for the deep water of the Sulu Basin showed good agreement (Graham, 1949). Two of these Watanabe thermometers were tested by the "Galathea" in the Mindanao Deep in August, 1951, and

they were able to withstand a pressure of 815 atmospheres. The thermometers give readings consistently reliable to 0.02° C.

Water bottles.—Water samples are taken using the two-plug valve-type Nansen bottle of liter capacity. This type of bottle has the advantage over the modified flap-type Nansen sampler in that its reversing mechanism can be tripped by a lighter messenger. Its drawbacks, however, are: it is apt to close prematurely, and samples taken at subsurface levels may get contaminated while in transit to the upper layers of the water column, due to malfunctioning of the valves caused frequently by rough sea conditions.

STATION POSITIONS

Stations are predetermined, arbitrary, geographic positions, where the boat stops to take water samples. The choice of station position is dictated by the need of representative sampling, and by such factors as topography, nature of water circulation, and type of survey desired. On account of the fact that almost all the areas now under investigation are littered with war debris, these snags are taken into consideration in laying out the stations.

In areas adjoining the open sea, the stations are invariably distributed grid-fashion, such that the line of stations so laid cuts across the expected current. In island-studded spaces, where pockets of topographically isolated areas indicate basin conditions, stations are established over the deepest portion of the area and also over the effective sill or deepest threshold.

PROCEDURE AT STATION

Once the station is fixed, sampling is immediately commenced. Where more than one cast is necessary, the deepest cast is made first. If wind or water current causes the wire to incline to more than 8°, the boat is maneuvered to set the wire in nearly vertical position. However, a protected and an unprotected thermometers are always paired at appropriate levels to insure, during reduction of the data, the application of displacement corrections on wire depths recorded in cases when the wire angle unavoidably exceeds 8°. Messengers have been clocked at a speed of 200 meters per minute; this rate of descent affords the basis for determining when to haul the cast. Five minutes for shallow casts and 10 minutes for deep casts are allowed for the bottles and thermometers to attain thermal equilibrium with their surroundings.

Once aboard, the thermometers are read first and then samples for the chemical determinations are drawn in the following order: oxygen, phosphate, silicate, pH, and chlorinity. Chlorinity samples are taken to the shore-based laboratory where the analyses are made.

Plankton tows are run in between stations. Vertical plankton samplings are done after the water samples are in.

Owing to the slow speed of the winch, bathythermograph measurements have not been made a regular part of the hydrographic routine. Bathythermograph observations, whenever made, always precede the hydrographic sampling.

SERIAL OBSERVATIONS

Water samples are taken at the surface, and at 2, 5, 10, 20, 30, 50, 75, 100, 150, 200, 300, and 500 meters below the surface. In deeper areas, the first five standard levels below the surface are omitted; samples at 25 meters are taken instead. In shallow areas bottom samples are taken at a few meters above the bottom.

Samples are not regularly taken at depths greater than 500 meters, because below this level, seasonal changes in Philippine waters are believed to be no longer operative or are at a minimum.

In the top layers, it is desirable to shorten the sampling intervals. These intervals are, however, limited by the length of the Nansen bottles, which cannot be operated in series at less than one-meter intervals on the line.

ANALYTICAL PROCEDURES

With the exception of the pH determination, all the analyses are based on unpublished mimeographed notes prepared by Thompson and Robinson of the Oceanographic Laboratories of the University of Washington. In the following discussions of the analytical procedures, no attempt has been made to describe the chemistry of the method, nor the details of the procedure. These are amply covered in relevant literature. Only such modifications as have been adopted to suit our purpose have been treated.

Chlorinity.—The amount of halogens in the sample is determined by a modification of the Oxner–Knudsen method using a Knudsen bulb, burette, and a 15-ml. automatic tap pipette. A bulb flask, filled with a weak solution of potassium chromate and set before an artificial light, has proved to be a handy

aid in sharpening detection of the end point of the titration. Standardization is against a secondary sea-water standard whose chlorinity has been fixed by Woods Hole standard sea-water. Copenhagen water will be used, after we have exhausted our present stock of secondary sea-water standard.

The preparation of a secondary standard sea-water is covered by Lyman's procedure. A slight modification that we have found highly desirable is the dipping of the tops of the citrate bottles containing the secondary standard sea-water in molten paraffin wax to insure their seal.

Chlorosity values are converted into chlorinities using the table for conversion of Cl/l at 20° C. to Cl°/$_{oo}$ prepared by Thompson (1928, 1930). In line with standard practice, salinities are used in dynamic computations.

The chlorinity determinations are believed to be accurate to within 0.02°/$_{oo}$.

Dissolved oxygen.—Dissolved oxygen is determined using the Winkler titration method. In line with more recent practice, however, we are using a standard potassium iodate solution of 0.01 normality. In order to get more significant figures for titration volumes, we have also adjusted the concentration of our sodium thiosulfate solution to about 0.005 normality. Sodium furoate is used in the amount of 0.1 per cent by weight to inhibit bacterial action. The buffering action of this chemical makes it unnecessary to boil out carbon dioxide from the water used in preparing the thiosulfate solution (Jentoft, 1949). As an inhibitor of the growth of mold in the starch indicator, we use a pinch of mercuric iodide regularly.

The routine precision of the determination is about 0.002 mg. atom, or 0.02 ml./l of sea-water.

Inorganic phosphates.—The method of Deniges is the basis of the determination of soluble phosphates in sea-water. To avoid applying the customary salt error correction on the phosphate values, synthetic sea-water of about 18°/$_{oo}$ chlorinity is used in diluting the standards for comparison. This is prepared by dissolving 33.6 grams of sodium chloride in a liter of phosphate-free distilled water.

The accuracy of the determination is of the order of 5 per cent to 10 per cent.

Silicates.—Silicates are determined by using the method developed by Dienert and Wadenbulcke as applied by Atkins to oceanographic work. For comparison, we have been using the "preferred standard of potassium chromate", rather than the

"alternate method" of using picric acid as standard. The latter keeps unchanged in its chemical properties for a period of months, the former even longer. As in the colorimetric determination of inorganic phosphates, Nessler tubes are used in measuring the silicate content of water samples.

Hydrogen-ion.—The pH is measured with the Beckman pH meter.

NOMENCLATURE AND UNITS

The scheme of nomenclature and units adopted follows that of the *Baird.* Chlorinity and salinity are expressed in parts per mille of weight in accordance with the definition on which the Knudsen Hydrographic Tables are based. To-date our areas of investigations have been always confined to coastal and inland seas, and so dynamic computations of currents for these regions have not been deemed practicable. Therefore, except in cases when water masses are examined or oxygen values computed for degrees of saturation, we have always used chlorinity in expressing halogen concentration.

Oxygen values are expressed in milligram-atoms or in milliliters/liter at 27.5° C., a unit useful to physical oceanographers, and on the basis of percentage saturation, which is the more preferred unit in biological studies. The degree of saturation includes the effects of temperature and salinity, and provides a measure of availability to organisms.

The concentration of nutrient salts is expressed in microgram-atoms/liter of sea-water at 27.5° C.

For purposes of volume measurements, we have adopted 27.5° C. as our standard temperature, although the indicated temperature of calibration of our laboratory glassware is at 20° C. The error introduced in using this standard room temperature in the Philippines is insignificant, compared to the error in the determination of chlorinity, which has the highest accuracy of all the chemical analyses run on our water samples.

In all other cases involving measurement, the metric system has been adhered to in line with IPFC practices.

SUMMARY

1. The 30-ton combination fishing vessel, M/V *David Starr Jordan,* was rigged with a crude hydrographic sampling set-up which permitted the collection of water samples from moderate depths within a tolerably short time. A portable compact work table mounted on the after deck provided the facilities for the shipboard analysis of the water samples.

2. The Japanese-made, deep-sea reversing thermometers used, gave readings consistently accurate to within 0.02/C. The water bottles were of the Nansen plug-valve type of liter capacity.

3. Bathythermograph observations and vertical plankton sampling, whenever made, preceded and followed respectively, the hydrographic sampling. Plankton tows were run in between stations. Water samples were ordinarily taken at the surface, and at 2, 5, 10, 20, 30, 50, 75, 100, 150, 200, 300, and 500 meters below the surface.

4. Chlorinity was determined using the modified Oxner–Knudsen method. Standardization of the titer was against a secondary sea-water standard whose chlorinity had been determined, using Woods Hole standard sea-water.

5. Dissolved oxygen was determined by the modified Winkler method. The strength of the thiosulfate solution was adjusted to half the standard normality to gain more significant figures for titration volumes. Oxygen content was expressed in mg-atoms/l or ml/l.

6. Inorganic phosphates were determined using synthetic sea water of about $18°/_{oo}$ chlorinity for diluting the standards. For comparison, in the determination of silicates, a series of potassium chromate standard solutions were used. The concentrations of the chemical nutrients were expressed in microgram-atoms/l.

7. The standard temperature used was 27.5° C.

REFERENCES

GRAHAM, H. W. (1949). A contribution to the oceanography of the Sulu Sea. *Proc. 5th Pacific Science Congress.*

JENTOFT, R. (1949). Analytical methods used aboard the *Baird.* Filed reports of the Philippine Fishery Program of the U. S. Fish and Wildlife Service.

THOMPSON, T. G. and R. J. ROBINSON (1947). Mimeographed notes on the chemical methods used in determining certain constituents of the water. Oceanographic Laboratories, University of Washington, U.S.A.

DEVELOPMENT OF A COAL-TAR NET PRESERVATIVE [1]

By Jose I. Sulit, Bienvenido Datingaling and Pacifico Pañganiban
Of the Bureau of Fisheries, Manila

FIVE TEXT FIGURES

ABSTRACT

Undiluted coal tar net preservative does not easily dry in a warm climate, thus making the net too heavy, messy, and hard to handle. To solve this problem, a coal tar net preservative diluted with gasoline was developed with the purpose of revolutionizing net preservation in the Philippines, where tan bark extract and blood are commonly used. The diluted preservative reduces the amount of coal tar deposited in the gear to an extent that the increase in weight is quite negligible.

Diluted coal tar showed preserving qualities on cotton twines exposed to the atmospheric weather and on those immersed continuously or intermittently in brackish and marine waters. However, the imported diluted coal tar containing rosin showed better preserving qualities.

Coal tar is a mineral product obtained by the destructive distillation of bituminous coal at 1100°–1300° F. together with coal tar and other ammoniacal compounds inherently present in coal. On further fractional distillation of coal tar, antiseptic compounds such as phenols, creosote, naphthols, pyrimidine bases, etc., are produced. The protective coating which coal tar provides and its antiseptic property are responsible for its use as an efficient net preservative against the destructive effects of microorganisms and abrasion so that, although careless handling and improper care of gear are often responsible for some losses, the use of coal tar is justified and lessens such risks.

Taylor (1920, 1923) and Conn (1930), in their pioneering studies on net preservatives, recommended coal tar as a net bactericide and as a protective coating against abrasion. Because coal tar is insoluble in water, it renders the gear impervious to water, thereby enhancing quick drying even in the shade. This is highly desirable because sunlight causes rapid deterioration brought about by oxidation.

There are objections to the use of undiluted coal tar as a net preservative, most important of which are the tremendous

[1] Contribution of the Philippine Delegation to the Fourth Meeting of the I.P.F.C. at Quezon City, Philippines, October 23 to November 7, 1952.

increase in the weight of the gear, handling difficulties, and fire hazards. In tropical countries, the climatic condition renders the nets too messy and therefore hard to handle. But as early as 1920, Taylor recommended a mixture of coal tar and copper oleate diluted with benzene, a volatile organic solvent. Johnson (1947), Technical Adviser of the Commonwealth Training School at Cronulla, advocated a mixture of 4 parts of coal tar, 1 part diethylene and 2 parts water as an efficient net preservative. At boiling point, penetration of the resulting solution is instantaneous, resulting in a more practical and less laborious application.

Whiteleather and Brown (1945) admitted that coal tar should not be recommended as a net preservative in the tropics. However, if coal tar is diluted with a suitable volatile organic solvent, it need not be heated to promote instantaneous penetration into the twines or nettings. After removing the excess material by pressing, drying can be accomplished in a matter of a few hours only. Firth (1945, 1948) and Conn (1930) recommended gasoline as a much better solvent for coal tar because of its high volatility and availability. The use of this solvent as a thinner reduces the amount of coal tar deposited in the gear to an extent that the increase in the final weight is quite negligible.

Farrar (1950), Robertson (1930), Bright (1926), Dubos (1928), Fleming (1921), McBeth (1913), and Carrothers (1949) are among the workers who claimed that one of the causes of net deterioration is bacterial in nature. Therefore, the use of coal tar would serve efficiently against such, because it contains as main constituents antiseptic compounds such as phenols, creosote, naphthols, pyrimidine bases, etc. Robertson also proved that weathering deteriorates nets, although drying causes less bacterial action due to lack of moisture. The deterioration effect is caused by oxidation. More damage is produced in the presence of chemicals like the copper compounds. In this connection, coal tar-treated nets should be hung and dried in the shade with an abundance of circulating air.

In undertaking this study, we aimed to determine a coal-tar-gasoline solution or mixture which would be most effective against deterioration of cotton twines subjected to various conditions such as weathering, continuous and intermittent immersion in both sea and brackish waters. It is hoped that the use of such preservative may revolutionize net preservation

in the Philippines from the standpoint of cost of labor, practicability, and interval of treatment.

MATERIALS AND METHODS

Materials.—The brand of coal tar used in this experiment was the master mineral black coal tar distributed by a local firm. It is soluble in organic solvents such as acetone, carbon tetrachloride, ether, chloroform and gasoline. It is partly soluble in kerosene. If used as a diluent, any of the aforementioned solvents may be used to make the solution.

Another brand of imported commercial net preservative used in this experiment was the "Texaspaltic Net Drip" manufactured by the Texaspaltic Company, New Orleans, Louisiana, U. S. A. It is claimed to protect nets from rots and abrasion. It contains rosin, coal tar, texaspaltic acid, benzene, and an alkali-proofing compound. In the label may be found the following directions: "Have nets thoroughly dry and clean. Completely saturate with undiluted net drip. Hang to dry for 24 hours. Nets will then be ready to use."

As a diluent, gasoline was used from the standpoint of price and availability. The following is a classified list of the canvassed prices of suitable organic diluents for coal tar:

1. Coal tar, 5 gallons	₱17.50
Kerosene, 1 gallon	0.67
Chloroform, 1 gallon	27.00
Total	₱45.17
2. Coal tar, 5 gallons	₱17.50
Kerosene, 1 gallon	0.67
Carbon tetrachloride, 1 gallon	7.80
Total	₱25.97
3. Coal tar, 5 gallons	₱17.50
Kerosene, 1 gallon	0.67
Acetone, 1 gallon	3.00
Total	₱21.17
4. Coal tar, 5 gallons	₱17,50
Kerosene, 1 gallon	0.67
Gasoline, 1 gallon	0.88
Total	₱19.05

5. *a.* Coal tar, 5 gallons	₱17.50
Gasoline, 2 gallons	1.76
Total	₱19.26
b. Coal tar, 5 gallons	₱17.50
Gasoline, 3 gallons	2.64
Total	₱20.14
c. Coal tar, 5 gallons	₱17.50
Gasoline, 4 gallons	3.62
Total	₱21.12

The cotton twine used was the No. 9, 3-ply, available in 1-lb. bundles. The brand was the international Seine Twine, manufactured and distributed by the International Company, U. S. A.

Methods.—The cotton twine was cut into equal lengths of 30 inches. A total of 30 bundles consisting of 175 pieces of the prepared twine were used. The bundles were divided into 5 parts, designated as A, B, C, D and E. In order to identify one from another, the twines were knotted as follows:

	Bundles
I. A_1 with 1 knot	2
A_2 with 2 knots	2
A_3 with 3 knots	2
II. B_1 with 1 knot	2
B_2 with 2 knots	2
B_3 with 3 knots	2
III. C_1 with 1 knot	2
C_2 with 2 knots	2
C_3 with 3 knots	2
IV. D_1 with 1 knot	2
D_2 with 2 knots	2
D_3 with 3 knots	2
V. E_1 with no knot	2
E_2 with no knot	2
E_3 with no knot	2

The prepared twines were immersed in their corresponding coal tar solutions A, B, and C and in the imported ready-made coal tar D. The twines were immersed for five minutes and the excess solution removed by evenly pressing the bundles with the hands; then they were hung and dried in the shade with free-circulating air. After four hours all the treated twines were completely dried. The increase in weight after treatment was determined.

The experiment was divided into three parts, according to the nature of exposure, as follows:

1. Weathering.
2. Continuous immersion in the sea and brackish water.
3. Intermittent immersion in sea and brackish water.

The schedule of exposure and sampling was as follows:

(*a*) *Weathering.*—One portion consisting of five bundles (A, B, C, D and E) was exposed to the atmospheric weather, and sampling was done once a week.

(*b*) *Continuous immersion.*—Same number of bundles as in (*a*). The bundles were continuously immersed in sea and in brackish water. Sampling was once a week.

(*c*) *Intermittent immersion.*—The schedule of immersion was as follows:

1. Saturday, 8:00 A.M.	Immersion.
2. Monday, 4:00 P.M.	Removal from the water and hanging to dry.
3. Tuesday, 8:00 A.M.	Immersion.
4. Thursday, 8:00 A.M.	Removal from the water and hanging to dry.
5. Friday, 8:00 A.M.	Sampling and immersion.
6. Monday, 4:00 P.M.	Repeat as of last week.

In sampling, five twines were removed from each bundle, then washed thoroughly with fresh water and dried.

RESULTS AND DISCUSSIONS

The intensity of color and the amount of coal tar deposited in the twine varied according to the density of the prepared coal tar solutions; that is, the higher the percentage of coal tar, the higher was the percentage increase in the weight of the treated twines (Table 1). Table 1 shows also that dilution B and the imported texaspaltic net drip, designated as D, yielded practically the same average increase in weight.

Intermittent submersion.—Table 2 shows the actual breaking strain of the treated twines submerged in sea and brackish water. Twines A, B and C, in brackish water, lasted 91 days; D, 98 days, and the control E, 70 days. On the other hand, in the sea, A, B and C lasted 70 days; D, 84 days and the control E, 56 days. The results of the experiment proved that coal tar shows protective quality against deterioration of twines submerged continuously or intermittently in the sea or

TABLE 1.—*Increase in weight of the twine after treatment with various dilutions of coal tar.*

Dilutions	Weight of twine		Increase in weight		
	Before treatment	After treatment	Grams	Per cent	Average
	gm	*gm*			
A-1	146.3	220.0	73.7	50.37	
A-2	144.7	218.5	73.8	51.00	
A-3	144.5	215.5	71.0	49.13	50.67
B-1	131.4	186.0	54.6	41.55	
B-2	145.5	221.0	75.5	51.88	
B-3	151.0	216.5	65.5	43.37	45.27
C-1	142.0	202.5	60.50	42.60	
C-2	144.5	207.5	63.00	43.59	
C-3	129.6	181.0	51.40	39.66	41.95
D-1	145.6	211.0	65.40	44.91	
D-2	143.3	210.0	66.70	46.54	
D-3	144.5	212.5	68.00	47.06	46.17
E-1	151.1				
E-2	162.0				
E-3	152.5				

in brackish water. It is likewise evident that the imported coal tar solution D, containing rosin in addition to the antiseptic compounds inherently present in coal tar, exhibits higher preserving quality than coal tar alone. More experiments along this line should be continued in order to get more conclusive results.

TABLE 2.—*Comparative average actual breaking strain in kilos of cotton twines exposed intermittently in brackish and sea waters.*

Number of days exposed	Brackish water				
	A	B	C	D	E
	9.30	8.18	7.86	8.96	11.44
7	7.80	8.60	8.90	11.50	10.42
14	8.08	8.50	8.30	11.30	9.38
21	8.26	8.70	7.40	13.52	9.28
28	8.06	7.96	7.26	11.70	7.00
35	6.90	6.02	5.40	11.20	4.84
42	5.90	6.19	5.02	9.98	4.00
49	6.37	5.18	4.55	8.96	2.68
56	6.10	5.68	4.85	9.60	0.61
63	4.15	4.05	5.20	6.80	0.58
70	4.10	3.70	2.20	6.70	0.31
77	3.76	3.50	2.18	4.48	
84	2.86	2.03	1.93	3.43	
91	1.52	1.02	.04	2.04	
98				1.04	
105					

TABLE 2.—*Comparative average actual breaking strain in kilos of cotton twines exposed intermittently in brackish and sea waters.—(Cont.)*

Number of days exposed	Sea water				
	A	B	C	D	E
	9.30	8.18	7.86	8.96	11.44
7	9.64	8.54	8.20	9.30	8.86
14	8.15	7.50	7.35	10.01	7.88
21	7.75	7.75	7.03	9.50	6.48
28	6.63	6.15	5.60	8.45	4.48
35	6.31	6.44	5.90	8.00	3.05
42	6.54	5.31	4.68	7.20	2.40
49	5.11	4.53	3.96	6.28	1.43
56	4.48	3.84	3.98	5.24	1.78
63	2.45	1.07	1.15	3.05	----
70	0.93	0.42	0.09	2.04	----
77	----	----	----	1.62	----
84	----	----	----	----	----
91	----	----	----	----	----
98	----	----	----	----	----
105	----	----	----	----	----

Intermittent submersion of the twines proved that deterioration is faster in the sea than in brackish water (Table 2). However, Farrar (1950) claimed that during summertime, net deterioration is faster in brackish water than in sea water. His claim holds true when the treated twines are continuously submerged, as reported in Table 3, which reveals that on the

TABLE 3.—*Comparative average actual breaking strain in kilos of cotton twines exposed continuously in brackish and sea waters.*

Number of days exposed	Brackish water				
	A	B	C	D	E
0	9.30	8.18	7.86	8.96	11.44
7	9.20	8.80	8.40	9.40	10.40
14	7.52	7.46	6.18	9.36	7.58
21	5.28	4.20	6.06	10.22	5.06
28	2.46	3.54	5.50	11.04	3.52
35	0.50	1.88	2.24	10.96	0.76
42	0.41	----	0.84	7.00	----
49	0.40	----	0.36	7.00	----
56	----	----	----	2.90	----
63	----	----	----	2.44	----
70	----	----	----	1.92	----
77	----	----	----	1.54	----
84	----	----	----	0.91	----

Number of days exposed	Sea water				
	A	B	C	D	E
0	9.30	8.18	7.86	8.96	11.44
7	9.10	9.34	8.50	11.36	9.56
14	7.25	7.36	6.43	9.36	7.38
21	7.75	7.75	7.03	8.45	6.48
28	6.63	6.15	5.60	9.50	4.48
35	1.93	1.41	0.81	8.12	0.94
42	0.93	1.05	0.93	6.26	----
49	----	----	0.06	2.80	----
56	----	----	----	1.86	----
63	----	----	----	----	----
70	----	----	----	----	----
77	----	----	----	----	----
84	----	----	----	----	----

TABLE 4.—*Average actual breaking strain in kilos of cotton twines exposed to atmospheric weather.*

Number of days exposed	A	B	C	D	E
0	9.30	8.18	7.86	8.96	11.44
7	8.04	7.42	7.94	8.08	9.22
14	9.74	9.60	10.44	9.44	11.01
21	8.62	8.15	9.16	9.02	10.10
28	8.33	7.31	7.85	8.71	8.43
35	7.91	7.48	7.83	8.80	8.10
42	7.90	7.60	8.28	8.30	7.70
49	7.80	6.92	7.79	8.20	7.80
56	6.65	7.61	8.03	7.93	6.63
63	7.51	6.18	7.33	7.85	6.41
70	7.00	6.16	6.41	7.00	6.28

28th day after continuous submersion, those in the sea demonstrated higher breaking strain than those in brackish water, but the continuous striking of the waves against the twines resulted in the abrupt lowering of the breaking strain, thereby deteriorating the twines submerged in the sea in a very much shorter time.

Continuous submersion.—The result of the experiments of the twines continuously immersed in brackish water and in the sea corroborates the claim of Farrar (1950) that deterioration is faster in brackish water than in sea water. It proved that the imported coal tar D, containing a certain percentage of rosin, preserved the twines longer, whether such twines were submerged intermittently or continuously in brackish water or in the sea.

The twines exposed to the atmospheric weather deteriorated gradually. On the 77th day, the twines A, B, C, D, and E showed definite deterioration, although bacterial action was less due to drying. However, the treated twines A, B, C, and D seemed to have little resistance to weathering as compared to the control E which gave the lowest breaking strain.

The experiments on gear preservatives conducted by Clague and Datingaling (1950), used pure pine tar and pine tar with creosote which proved to be two of the most effective net preservatives. These preservatives, however, do not seem to be suitable for use in the Philippines, because the tropical climate renders the gear messy and consequently inconvenient to handle. But the use of coal tar properly diluted with a quick drying organic compound renders the net impervious to water, which condition enhances rapid drying even in the shade with a continuous draft. The increase in weight was reduced

from almost 100 per cent in the case of pure tar, to only about 50 per cent when properly diluted.

The extension work conducted by Mr. Gonzalo Ferrer, Gear Technologist of the Bureau of Fisheries, revealed that the use of a diluted coal-tar net preservative proved very successful in the Visayan Islands. According to him, there were cases when the otter trawl net was used continuously for six months without retreatment. When tan bark was used, retreatment was done twice a week which made the use of this common native net preservative impractical and uneconomical. The result of this experiment proved that the use of diluted coal tar protects the twines from deterioration, whether they are immersed intermittently or continuously, or exposed to atmospheric weather.

SUMMARY

The use of coal tar as a net preservative was reviewed. The fact that pure or undiluted coal tar is not practicable to use as a net preservative under the Philippine tropical climate, three dilutions of coal tar were prepared using gasoline as a diluent.

The experiment proved that coal tar diluted with gasoline preserved cotton twines (figs. 1–5) when submerged continuously or intermittently in both brackish and sea water.

Diluted coal tar with rosin as exemplified by the imported coal-tar net preservative D, has higher preserving qualities than any of the other pure coal tar dilutions (figs. 1–5).

In the absence of the imported ready-made coal-tar net preservative D, pure coal tar diluted with gasoline would serve well as a preservative for dragging nets under Philippine climatic conditions. Because diluted coal tar impregnates the cotton fibers instantaneously without the aid of heat, it eliminates the usual fire hazard and the tremendous increase in weight. Coal tar renders the cotton fibers impervious to water, which makes drying quick, even when the net is hung in the shade with continuous air circulation.

In one of the demonstration trips in the Visayas, a fisherman, using an otter trawl net preserved in diluted coal tar, managed to fish continuously for six months under very unfavorable weather conditions without retreating his net. The use of diluted coal tar as a net preservative is now very popular in the Visayas.

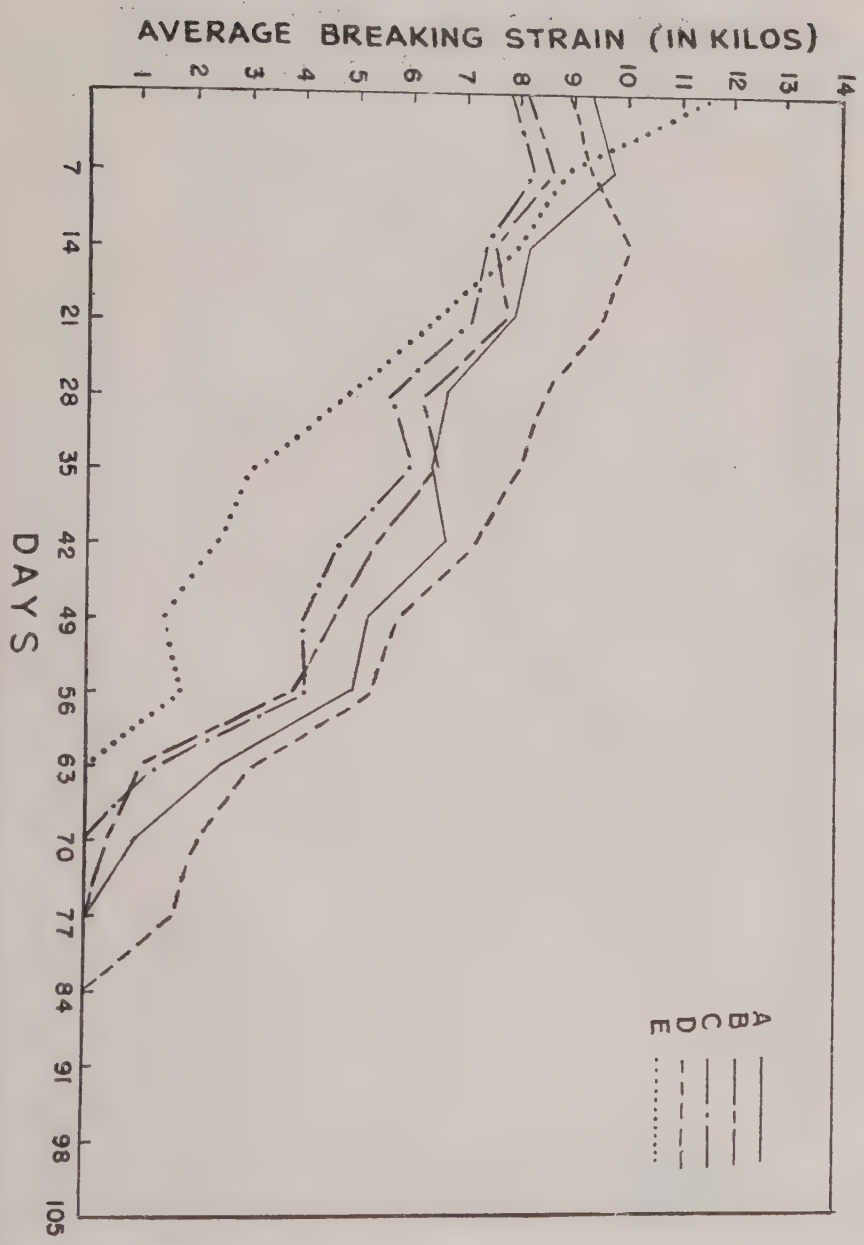


FIG. 1. Average actual breaking strain in kilos of cotton twines submerged intermittently in sea water.

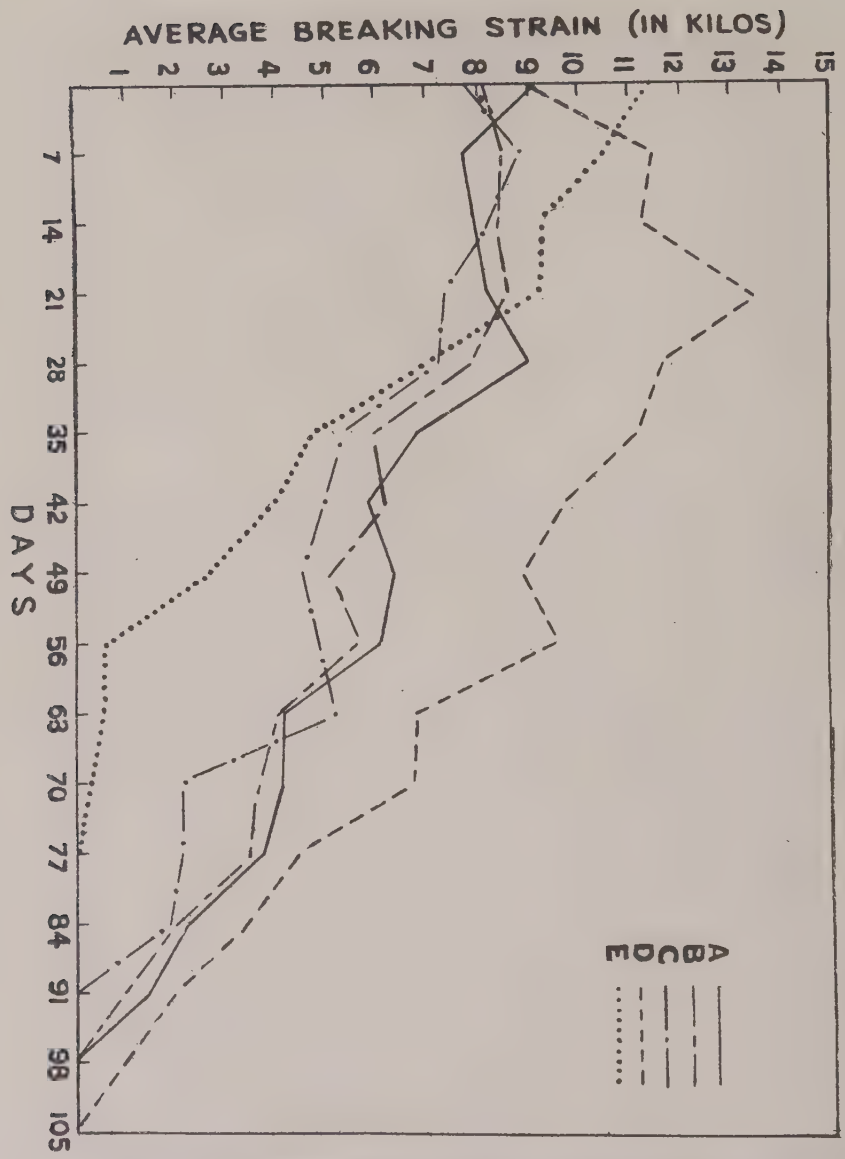


FIG. 2. Average actual breaking strain in kilos of cotton twines submerged intermittently in brackish water.

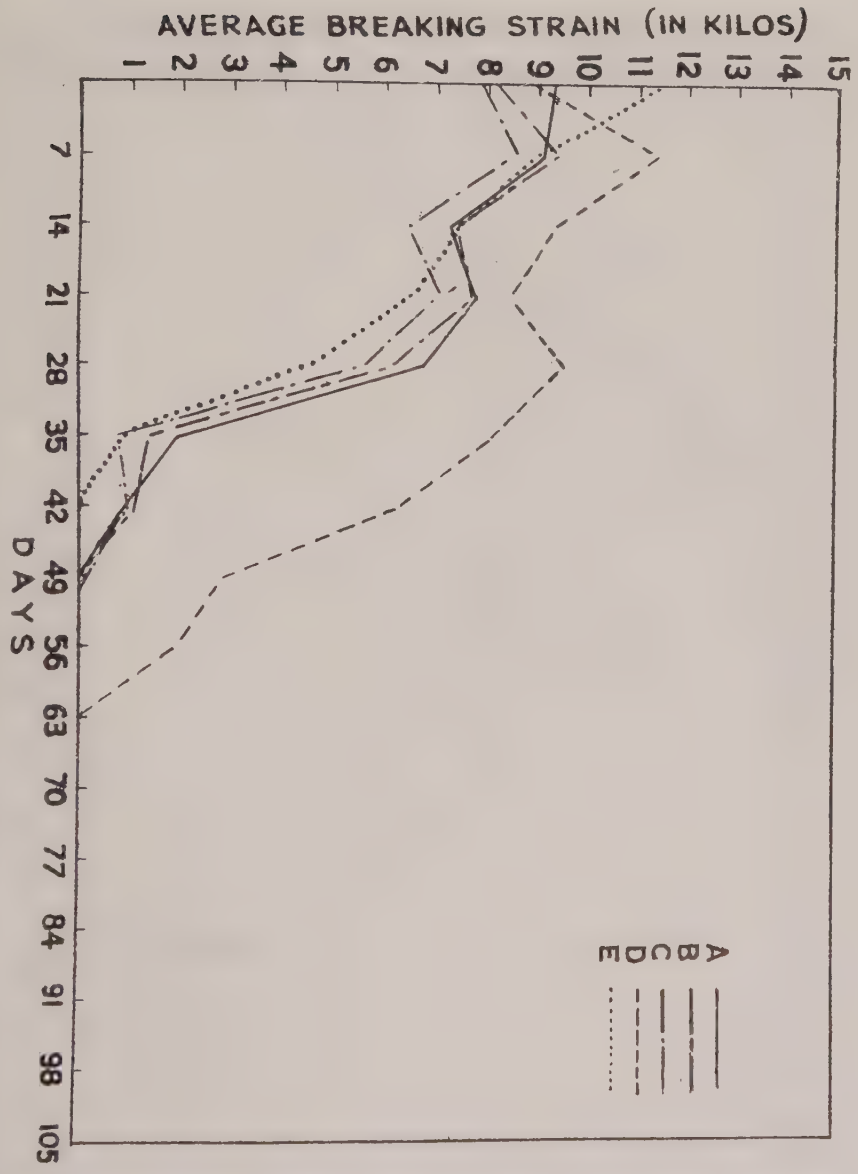


FIG. 3. Average actual breaking strain in kilos of cotton twines submerged continuously in sea water.

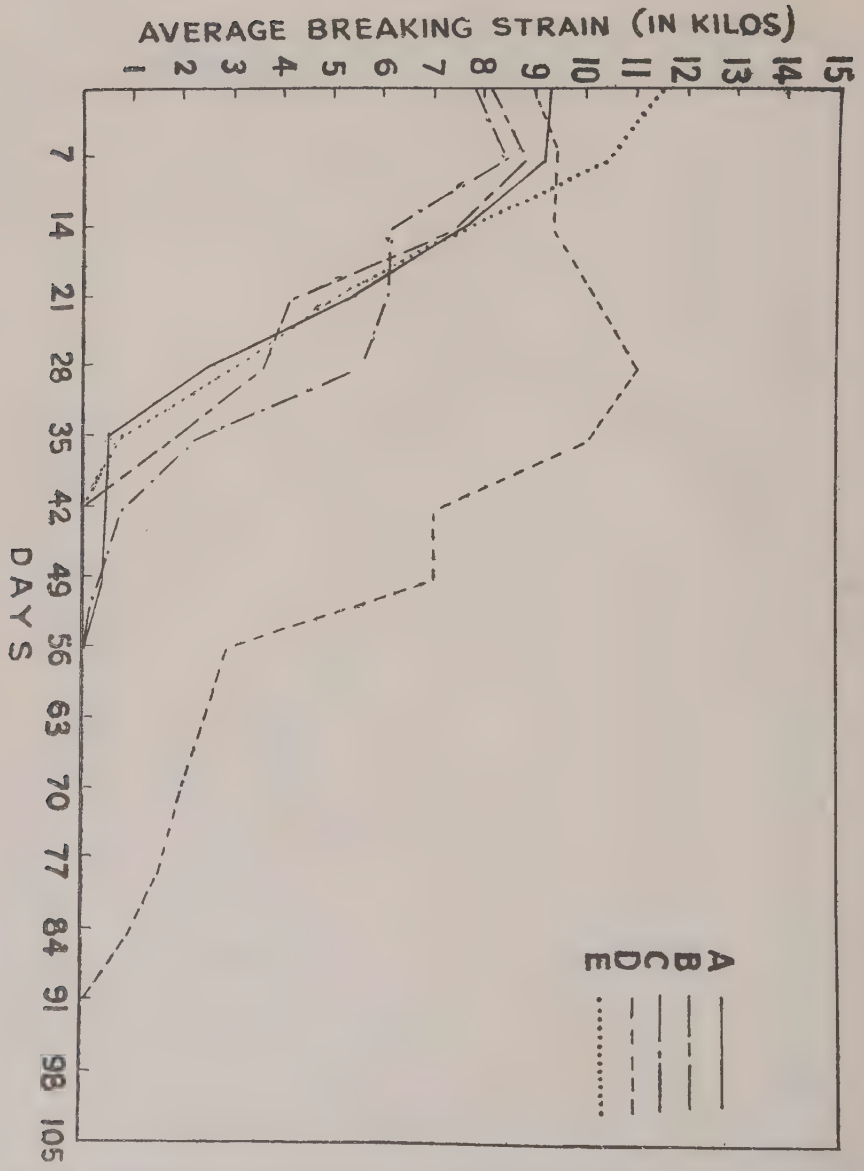


FIG. 4. Average actual breaking strain in kilos of cotton twines submerged continuously in brackish water.

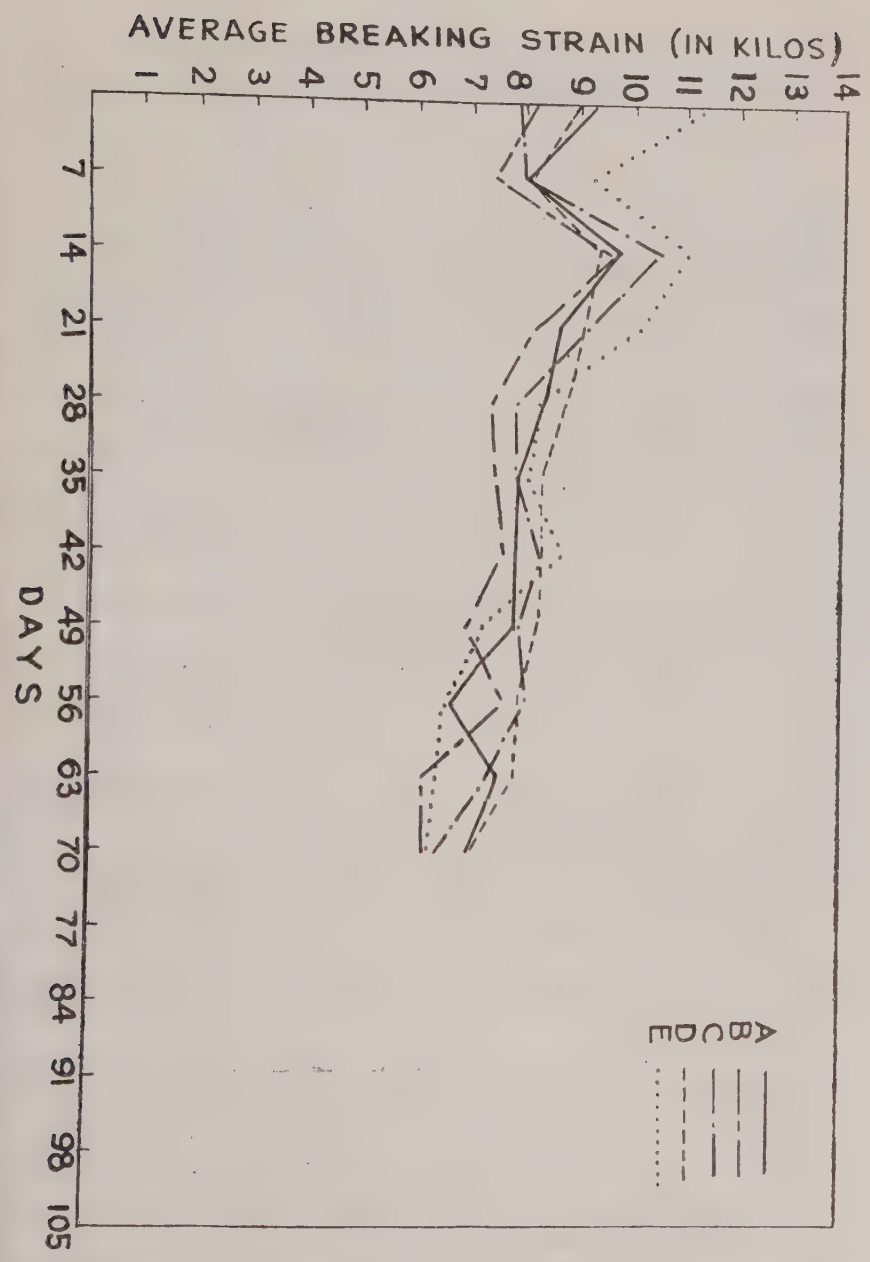


FIG. 5. Average actual breaking strain in kilos of cotton twines exposed in the atmospheric weather.

REFERENCES

BRIGHT, T. B. (1926). The microscopic examination of damaged cotton hairs by Congo Red Test and the swelling test of Fleming and Thaysen. Manchester, England. Text. Inst., Journ. Trans. 17: T396–T404.

CARROTHERS, P. J. G. (1949). Notes on cotton-web and its preservation with coal tar. Vancouver, British Columbia, Canada. Edward Lipsett, Ltd., 13.

CLAGUE, J. A. and B. DATINGALING. (1950). Fishing gear preservatives for Philippine waters. Washington 25, D. C. Research Report No. 22, Fish and Wildlife Service, U. S. Department of the Interior, 23.

CONN, W. T. (1930). Net preservative treatments. U. S. Bur. of Fish., Doc. No. 1075, Appendix III, Report of the U. S. Commissioner of Fisheries for 1930, 5.

DUBOS, R. J. (1928). The decomposition of cellulose by aerobic bacteria. Baltimore, Md., Journ. of Bacteriology 15: 223–234.

FARRAR, B. (1950). Studies on the preservation of fish nets. Brit. Col. Research Council (Tech. Bull. No. 11), Dept. of Comm. and Agric., 9.

FIRTH, F. E. (1944). Preservation and care of fish nets. Chicago 54, Ill. Fish. Leaf. 66, U. S. Dept. of Int., U. S. Fish and Wildlife Service.

FIRTH, F. E. (1948). The development of fish net preservatives. Cuprinol Div., Darworth Inc., Fishing Gazette, 64.

FLEMING, M. and A. C THAYSEN. (1921). On the deterioration of cotton on wet storage. Biochemical Journ. 15: 407–414. Chicago, Ill.

JOHNSTON, E. (1947). Preserving nets. Fish. Newsletter, Dept. of Comm. and Agric. 6: 18.

MCBETH, J. G. and F. M. SCALES. (1913). The destruction of cellulose by bacteria and filamentous fungi. Washington, Bull. 226, U. S. Dept. of Agric., Bureau of Plant Industry, 50.

ROBERTSON, A. C. and W. H. WRIGHT. (1930). Investigations upon the deterioration of nets in Lake Erie. U. S. Bur. of Fish., Doc. 1083, Appendix VIII, Report of the U. S. Commissioner of Fisheries, 149–176.

TAYLOR, H. F. (1920). Preservation of fish nets. U. S. Bur. of Fish., Doc. 898, Appendix IV, Report of the U. S. Commissioner of Fisheries, 35.

TAYLOR, H. F. and A. W. WELLS. (1923). Properties and value of certain fish net preservatives. U. S. Bur. of Fish., Doc. 947, Appendix I, Report of the U. S. Commissioner of Fisheries, 409–437.

WHITELEATHER, R. T. and H. H. BROWN. (1945). An experimental fishery survey in Trinidad, Tobogo, and British Guiana. Report of the Anglo-American Carribean Commission, Dept. of the Int., U. S. Fish and Wildlife Service, Washington 25, D. C.

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Average actual breaking strain in kilos of cotton twines submerged intermittently in sea water.

2. Average actual breaking strain in kilos of cotton twines submerged intermittently in brackish water.

3. Average actual breaking strain in kilos of cotton twines submerged continuously in sea water.

4. Average actual breaking strain in kilos of cotton twines submerged continuously in brackish water.

5. Average actual breaking strain in kilos of cotton twines exposed in the atmospheric weather.

TWO PHILIPPINE BORING MOLLUSCS

By GUILLERMO L. ABLAN
Zoologist, Bureau of Fisheries, Manila

ONE PLATE

Pholads are known to attack rocks of various kinds by tunnelling or rasping holes in similar manner as teredo does in wood. Among rock borers, *Parapholas concamerita* Desh., is reported to occur and to be fairly common on the rocky coasts of the Philippines. This species measures 3 inches or more in length. Ablan (1938) noted *Pholas orientales* Gmelin living in colonies, burrowing in the sandy mud in Pontevedra, Negros Occidental. Many of this species were removed from the soil 9 to 22 inches deep.

Among molluscan borers the teredo is the most destructive wormlike bivalve. Its shells at one end are reduced to a pair of hard chisels which are moved up and down by powerful muscles with which to excavate its burrow in the wood. Its stomach secretes a digestive ferment which converts some of the wood into sugars. The teredo is considered to be one of the few highly organized animals capable of digesting wood fiber. It is the only boring animal in the sea dependent for food and shelter on the material which it bores and is so highly especialized that it can only begin a burrow at a very early stage of its existence. If an adult teredo is dislodged from its burrow, it cannot make a new one but dies helplessly.

The writer, on October 15, 1948, came across a floating piece of worn-out piece of wood (*Avicennia officinalis* Linnæus) measuring about a meter long and 15 centimeters in diameter badly tunnelled on the surface and drifted ashore by the tide in the Provincial Demonstration Oyster Farm at Manat, Binmaley, Pangasinan Province. Splitting the wood with a hatchet, he dislodged and saved for study two species of molluscs embedded in large number in the wood. The two species are of the genera *Gastrochaena* and *Barnea* of the family Pholadidæ. At present it is not known with certainty as to whether a certain species of the genera is specific to the kind of surface and nature of wood it attacks. *Gastrochaena rostrata* Speng., one of the species here described, attacks readily bamboo [*Bambusa*

spinosa Roxb. (Gram)] splits which are usually employed as oyster spat collectors and fish corrals. This borer also destroys spat collectors planted in oyster beds.

The attacked piece of wood is a mangrove species locally abundant along muddy seashores of Philippine tidal streams. Its ash is leached and the resulting liquor is an important ingredient in soap making. This particular wood is known locally as *kalapini, kalumpini* (Ilocos Norte, Pangasinan, Zambales); *mangitit* (Zambales); *bongalon* (Pangasinan, Polillo, Marinduque, Mindoro, Iloilo, Negros Occidental); *bungalin* (Pampanga); *api-api* (Bataan, Capiz, Mindoro, Masbate, Cotabato, Zamboanga); *api mavani* (Albay); *kuyapi* (Camarines); *pepisik* (Tayabas, Camarines); *miapi, piapi* (Tayabas, Samar, Leyte, Misamis); *kilassi* (Cotabato, Davao); *pundung* (Davao). Reyes (1933) characterizes this species of wood to have decidedly crossed grains which are irregularly wavy or twisted, slightly salty in taste, and perishable when exposed to weather or in contact with the ground.

DESCRIPTION OF SPECIES

BARNEA MANILENSES Phil. Plate 1, fig. 2.

Shell elongate and corncoblike, dull-white; anterior gradually bulging from posterior side; surface laminated with toothed clockwise ridges. Anterior tips sharp, anteventral margin toothed. Shell with an elongated and pointed shell piece. Inside shell surface whitish. Prominent spines present, one each below hinge of each valve. Open on both ends.

Measurement of Barnea manilensis Phil. in inches.

Sample number	Greatest thickness	Shell valves	
		Length	Width
1	3/4	2-3/16	3/4
2	5/8	2-5/16	3/4
3	11/16	2	3/8
4	7/8	2-7/8	3/4
5	3/4	1-7/8	3/4
6	11/16	2-1/16	5/8
7	11/16	2	5/8
8	7/8	2-3/8	3/8
9	5/8	1-15/16	5/8
10	3/4	2-9/16	3/4
11	11/16	2-1/8	11/16
12	11/16	2-1/8	11/16
13	5/8	2-1/8	5/8
14	3/4	2-1/4	11/16
15	5/8	2	5/8
16	5/8	1-13/16	5/8
17	5/8	1-7/8	5/8

The type specimen was collected in Manila and described as a fine white 2.5-inch shell which lives in burrows along the Philippine coasts. It is quite similar to other species of which there are a dozen or more in the genus.

GASTROCHAENA ROSTRATA Speng. Plate 1, fig. 4.

Shell irregular in shape, tapering posteriorly, bulkier and rounded anteriorly, well fitted with opening on both ends, crowned with a rounded shell piece. Fine undulating ridges present below crown. Prominent horizontal groove present on anterior of shell. Dull-white anteriorly, dull-yellow posteriorly. Interior of shell whitish. Under hinge a spine present on each valve.

These little borers are also common in the West Indies and can perform wonders with a good thick plank or post to work on. They will bore so many holes leaving only a skeleton of the object left which is easily crushed in your hands. There are three species on the east coast of the United States, from North Carolina southward. Some species bore in clay.

Measurement of Gastrochaena rostrata Speng. in inches.

Sample number	Greatest thickness	Shell valves	
		Length	Width
1	7/16	7/16	1/2
2	1/2	1-5/16	1/2
3	7/16	1-7/16	7/16
4	7/16	1-5/16	7/16
5	3/8	1-3/8	3/8
6	3/8	1-1/16	3/8
7	7/16	1-1/16	7/16
8	7/16	7/8	7/16
9	3/8	3/4	3/8
10	3/8	5/8	3/8

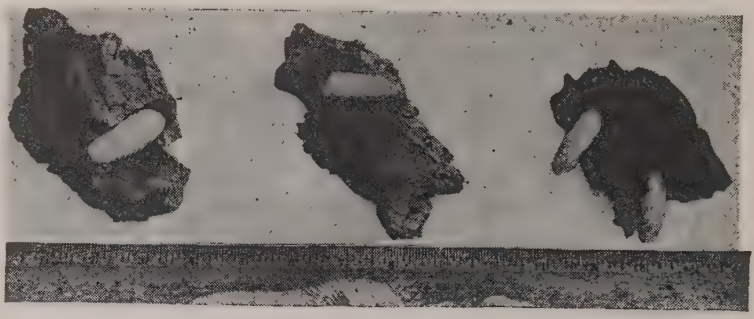
REFERENCES

1. Ablan, Guillermo L. The diwal fishery of Occidental Negros. Phil. Jour. Sci. 66 (1938) 379–385.
2. Reyes, Luis J. Philippine Woods. Tech. Bull. No. 7 (1933) 536.
3. Seddie, Laura Burkholder. Shells and other sea life of the Philippines. Oriental Commercial Company, Inc., Manila (1933) 145–146.
4. Thompson, Holland, Arthur Mee, and John Finley. The book of knowledge. Grolier Society, Educational Book Company 19 (1926–1927) 6888–6889.
5. Webb, Walter F. Handbook for shell collectors (1936) 171.

ILLUSTRATIONS

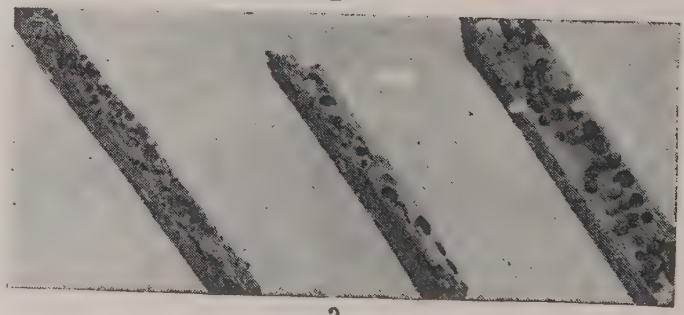
PLATE 1

FIG. 1. *Barnea manilensis.*
2. External and inside feature of shell of *Barnea manilensis.*
3. Surface of bamboo pieces attacked with *Gastrochaena rostrata.*
4. External and inside features of shell of *Gastrochaena rostrata.*



1

2



3

4

PLATE 1. BARNEA MANILENSIS.

LATTICE METHOD OF OYSTER CULTURE

By Guillermo L. Ablan

Zoologist, Bureau of Fisheries, Manila

THREE PLATES

Oysters, owing to their high nutritive value and the various uses of their by-products, are the most important bivalves for cultivation. A number of local species suitable for culture are widely distributed throughout the country. Several coastal localities that are potential natural grounds for oysters are awaiting exploitation. They consist of bays, gulfs, lagoons, mouth of rivers, tidal streams, estuaries and inland seas. However, only limited areas in regions thickly populated around Manila Bay and Lingayen Gulf are utilized. There is a great demand for oysters free from pollution and contamination. The methods of culture in existing oyster farms are similar to those practiced abroad. While these methods have their own advantages depending on prevailing local conditions, an improved device adaptable for use in most places here is described in this paper.

Ablan (1949) considers bamboo (*Bambusa spinosa* Roxb.), abundant locally, an ideal material for farming oysters. Considerations for its choice are: Easy to procure, reasonably priced, fairly durable, its workable quality to suit any design or style of spat collecting device adaptable and practical to use on any type of bottom and on either horizontal or vertical plane.

In Japan several methods of oyster culture are employed to make use of every possible area or space available. Observations on these methods reveal that oysters grow faster near the surface where food is more abundant, temperature higher, and water less saline.

Table 1.—*Comparative data on age of marketable size of oysters.*

Culture		Locality	Age	
			Years	Months
Bottom	Broadcasting empty shells.	Japan	3	
Vertical	Pendant	do	1-1/2 to 2	
Bottom	(1)	Philippines	1 to 1-1/2	
Vertical	Staking	do		6 to 10
Floatation	Lattice	do		

DISCUSSION ON THE LATTICE METHOD OF OYSTER CULTURE

Staking method (usoc, tulus, or darecdec) made out of bamboo trunk splits is employed in Binakayan, Cavite Province; San Fabian, Dagupan and Binmaley, Pangasinan Province; Carlatan Lagoon, San Fernando, La Union Province; and Abucay, Bataan Province. Repeated use of this method causes several difficulties. Hard sandy bottom requires much effort in staking bamboo trunk splits and if these are not stuck firm enough into the sandy soil they are uprooted due to wave action and practically lost. Seeded bamboo trunk splits with oysters cannot support the weight of growing oysters causing them to break. Portion of the stake buried in the soil does not produce any oyster. Harvesting oysters from stakes needs double effort to collect them. To minimize this difficulty, bamboo trunk splits are woven into lattice. Galvanized wire No. 14 is used as a tying material. The splits are spaced from 6 to 12 inches. On the average, a lattice varies from 10 to 16 splits and can easily be handled by an individual.

Bamboo lattice on a horizontal plane consists of the following methods:

1. Fence style, either stuck on the bottom or supported with bamboo trunk posts.
2. Tent formation in rows.
3. Lattice of several pieces can be mounted in racks set either singly or in layers.
4. Lattice with support can be laid on the bottom.

METHODS ON A VERTICAL PLANE

1. Floatation method—Lattice mounted on long bamboos and are reinforced with empty drums.
2. Suspension method—Three pieces of lattice assembled in a triangular form supported with long bamboos and empty drums.
3. Combination method—Floatation and suspension method using strings of empty shells.

ADVANTAGES OF BAMBOO LATTICE

1. A device usable singly or in a multiple series in either vertical or horizontal plane.
2. Eliminates losses of spat collectors and can support weight of growing oysters.
3. A labor-saving device for their layout and harvesting oysters.

4. Oysters raised do not touch the bottom and are protected from bottom enemies.

5. Practical for collecting, growing and fattening oysters.

6. Increases production not only per unit area of ground but in a three dimensional space.

7. Growth of oysters can be accelerated by placing them to suitable water level where food is abundant, temperature favorably high, and water is less saline.

Only four out of 23 species of oysters reported in the Philippines are of commercial importance. *Ostrea iredalei* Faustino, *Ostrea malabonensis* Faustino and *Ostrea palmipes* Sowerby are cultivated. *Ostrea cucullata* Born, growing wild in quantity on the rocky bottoms of Catbalogan, Samar Province, the center of salted "sisi" industry, is also of commercial importance. *Ostrea iredalei* Faustino is the most important as to size and quality. *Ostrea malabonensis* Faustino ranks second and *Ostrea palmipes* Sowerby comes third.

Orton (1937) graphically showed that *Ostrea edulis*, 1½ years old and about an inch in size, gives a 2½ cubic centimeters of meat as compared with the meat of Philippine oysters about 4 months old.

Oysters about 4 months old were raised on floated bamboo lattice set on December 1, 1949 and examined on March 23, 1950. They were detached for measurement of the size and volume of meat and the results are shown in the following table.

TABLE 2.—*Size and volume of meat of cultivated oysters about 4 months old by the lattice method.*

Species	Specimen examined	Average measurement of left valve in inches		Average measurement of meat in inches		Average volume of meat in cc.
		Length	Width	Length	Width	
Ostrea iredalei	25	2-1/4	1-1/4 to 2-1/2	1-1/8 to 2	3-4 to 1-1/2	4 to 7
Do	8	2-3/4	1-1/4 to 2-1/2	1-3/8 to 2	1 to 1-1/4	4 to 6.5
Do	3	3-1/4	1-1/8 to 2-3/8	1-3/4 to 2-1/4	1	5 to 6
Ostrea malabonesis	9	1-1/4 to 1-3/4	7/8 to 1-3/8	1 to 1-1/2	1/2 to 9/16	1 to 3
Do	9	2 to 2-1/4	1-1/4 to 1-3/4	1 to 1-1/2	7/8 to 1-3/8	1 to 3
Ostrea palmipes	20	1 to 2	7/8 to 1-1/2	3/4 to 1-1/4	1/2 to 7/8	1 to 2.5

REMARKS AND RECOMMENDATIONS

Oyster farming offers a lucrative venture in the Philippines as shown in the following:

1. Remarkable rate of growth.
2. Availability of extensive and potential grounds for oyster cultivation.
3. Presence of commercial species ready for exploitation.
4. Increasing demand for them as food and the various uses of their by-products.
5. Procurability of cheap materials for farming them.
6. Reasonable cost of labor prevailing and high yielding capacity of per unit area of space.

As a government agency, the Bureau of Fisheries should be given more appropriations for extension work on oyster culture. With sufficient funds available a well organized extension service may be established to undertake the establishment and supervision of more oyster farms for demonstration purposes, to make necessary survey of all potential oyster grounds in the country and to make a working program of developing them.

REFERENCES

1. Ablan, Guillermo L. The commercial production of oysters in the Philippines. Popular Bull. No. 26 (1949).
2. Glud, John R. Japanese methods of oyster culture. Commercial Fisheries Review, U. S. Fish and Wildlife Service 2 No. 8 (1949).
3. Orton, J. H. Oyster Biology and Culture. London, Edward and Co. (1937).

ILLUSTRATIONS

PLATE 1

Diagrammatic sketches of the lattice method.

PLATE 2

FIG. 1. Provincial Demonstration Oyster Farm House-Office and Laboratory.
2. Concrete ladder leading to Oyster Farm House.
3. Strings of oyster from lattice.
4. Bamboo lattice.
5. Bamboo lattice laid out in tent style.
6. Supporting weight of bamboo lattice laid out in tent style.
7. Side view of bamboo lattice laid out in tent style.
8. Several bamboo lattice in layers.

PLATE 3

FIG. 1. Bamboo lattice with strings of empty shells to collect oyster spats.
2. Three pieces of lattice in a triangular formation.
3. Floating bamboo lattice.
4. Floating bamboo lattice mounted to empty drums.
5. Seeded lattice tent formation.
6. Seeded lattice in layers.
7. Underside view of floated lattice with oysters.
8. Side view of floated lattice with oysters.
9. Strings of oysters in loop suspended from lattice.

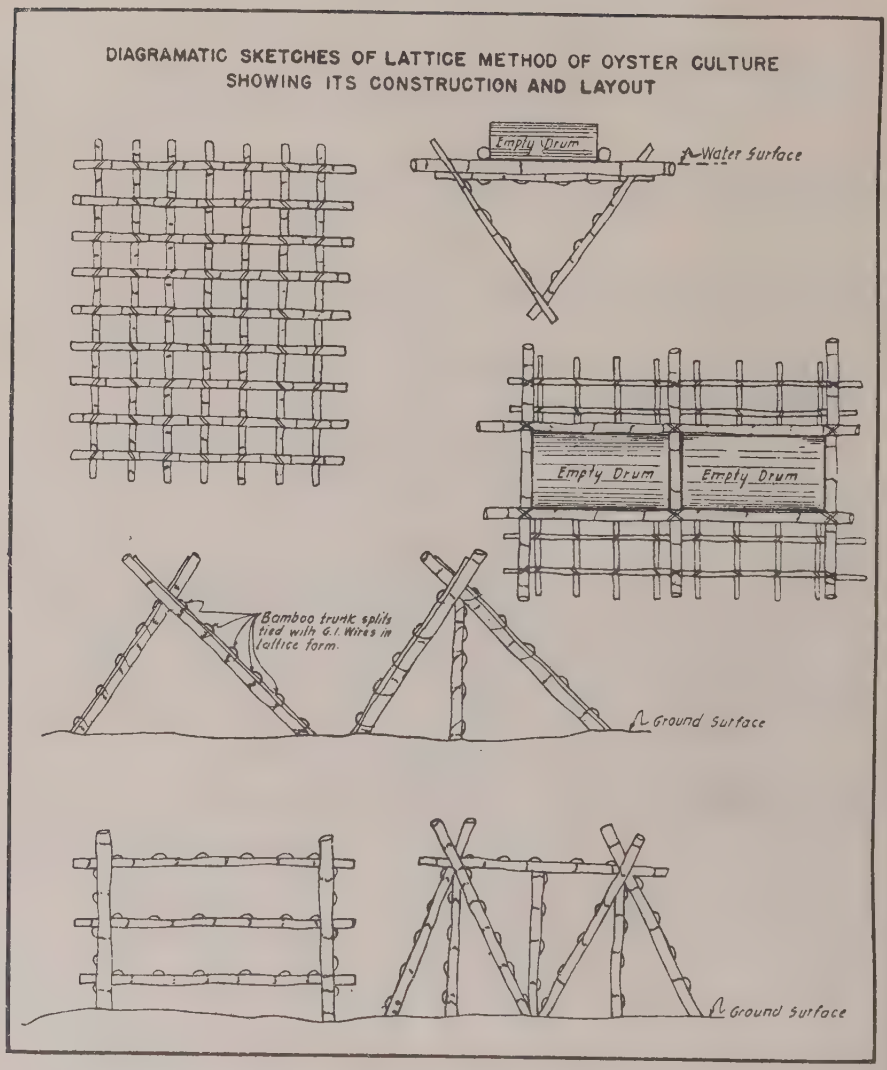
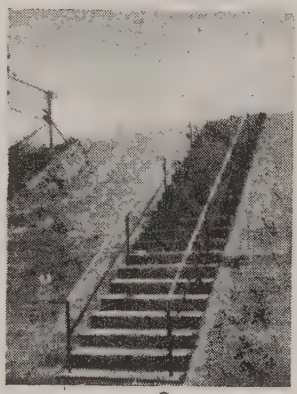


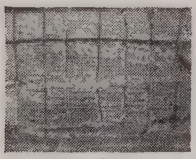
PLATE 1. DIAGRAMMATIC SKETCHES OF THE LATTICE METHOD.

1

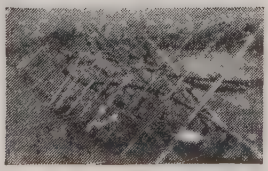


2

3



4



5

6

7

8

PLATE 2

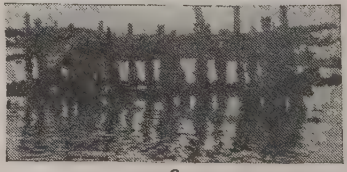
1

2

3

4

5



6

7

8

9

PLATE 3

NOTES AND OBSERVATIONS ON THE DANISH DEEP SEA EXPEDITION OF THE "GALATHEA" TO THE MINDANAO DEEP

By Teodoro G. Megia, Inocencio A. Ronquillo and Ricardo R. Medina
Of the Bureau of Fisheries, Manila

OBJECTIVES OF THE EXPEDITION

The Danish research ship pulled into the port of Manila on July 6, 1951, and four days later it steamed away on its scientific mission to the Mindanao Deep. Among the most outstanding objectives of the Expedition to the Mindanao Deep were: To gauge by sounding the much disputed depth of the trench trawl for deep-sea animals and fishes, find how far below the surface living things can exist, determine the bottom configuration of the Deep, take bottom mud samples for bacteriological and sedimentation studies, and make organic productivity measurements. Last but not least was the spreading of Danish goodwill, wherever the work of the Expedition took the ship in its two-year round-the-world cruise of scientific discoveries.

THE BOAT AND ITS PERSONNEL

Constructed in 1933, the corvette "Galathea" had a war record of many years. Until it was commissioned for its oceanographic mission round the world, the ship plied between Denmark and England as a tourist ship. With a tonnage of 1,630 tons, it had a length of 79.9 meters and a draft of three meters. With a cruising speed of 12 knots, it was equipped with an automatic pilot and a Decca radar. Its twin-propeller drive, a feature little exploited by research ships in general, multiplied manifold the maneuverability of the boat which was of great help in hove-to operations.

Manned by a staff of 10 officers and a crew of 79, the "Galathea" carried 17 scientists in addition to a number of foreign scientists who came on and off in the course of her cruise round the world. The ship was under the command of Capt. Svend Greve and the Expedition under the leadership of Dr. Anton F. Bruun, an expert on flying fishes and one of

the leading ichthyologists of the world. Dr. Torsten Gislen of the University of Lund, Sweden; Dr. Claude E. ZoBell of the Scripps Institution of Oceanography and the authors of these observations were among the foreign scientists, who joined the trip to the Mindanao Deep.

EQUIPMENT AND INSTRUMENTS

The most important equipment of the oceanographic vessel was the Hughes Recording Echo Sounder which in reality was the nerve center of all the boat's operations. The basic principles of the sounding machine revolved around the sending out of sound impulses from the bottom of the ship, measuring the time required for the resulting echo to return from the sea bed, and presenting the measurements in the form of a continuous graphical record of depth of water. The return of spurious echoes was reduced to a minimum by having the sound waves focused into a concentrated beam by a funnellike reflector, which projected the beam toward the sea bed. Soft bottom, air bubbles coming from the wake of the boat and creeping into the hydrophones, and the pitch and roll of the boat due to swells were the most important interfering factors, which introduced uncertainties in some of the recorded soundings.

The other important equipment used for deep-sea operations were the heavy dredge and hydrographic winches with tapered wires exceeding 12 kilometers in length. Both wire ropes contained a central core of hemp steeped in pitch. When payed out under load the wire stretched, thereby squeezing out the grease which under great pressures at ice-box temperatures congealed to form a thick coating of viscous material clinging around the wire. When a messenger was released to reverse the bottle clamped to the hydrographic wire, the speed of descent was greatly reduced by the clinging grease and by the progressive increase in viscosity of the successive layers of water, due to decreasing temperature and increasing pressure. Consequently, at the time the messenger hit the bottle, the force of impact was not sufficient to trip the mechanism that reversed the bottle. Seven successive failures in water sampling were believed due to such difficulty.

The dredges and trawls were of different types and sizes. A variety of types of trawl constituted the bulk of collecting gear. These were the sledge trawl, lobster trawl, shrimp and herring otter trawl, and the general purpose triangular otter

trawl. Most of the trawls had simple rectangular iron frames to which the collecting nets were attached. The nets tapered to collapsible cod ends, which were made of heavy canvass and supported by a pair of iron rings distanced a few inches apart. The dredges were smaller and had serrated iron frames.

The bottles, used for securing water samples, were of the modified Nansen type whose valves, when closed, sat on rubber gaskets. Heavily plated, each bottle carried a one-piece frame which housed the two deep-sea reversing thermometers. A number of the thermometers resisted pressure exceeding 1,000 atmospheres, while the others collapsed under those pressures. A number of the Watanabe (Japanese) thermometers of the Bureau of Fisheries tested during the trip withstood a pressure of 815 atmospheres.

For examining minute specimens, they had a special research microscope, whose construction was radically different from those in general use. The arm was at the front to give free access to the object, stage, objectives, substage and mirror, thus offering greater comfort and convenience to the user. The optical elements were Balcoted to avoid objectionable reflections which might interfere with the instrument in producing a sharper, clearer image most truly interpretive of the tonal characteristics of the specimen.

It is worthy to note at this point, that all the specimens collected were separated into phylogenetic groups soon after they were killed and then preserved and labelled accordingly. This was the first time that such practice was adopted in a long-range biological expedition.

ACHIEVEMENTS AND DISCOVERIES

In fulfillment of its first objective, the "Galathea" on July 29, 1951, at about 0024 hours, sounded a depth of 10,628 meters some distance away from the Snellius Deep, located approximately at 9° 42′ N and 126° 51′ E. It is interesting to compare it with soundings taken by other research vessels in previous years. The following table is a list of such soundings.

Nationality	Vessel	Year	Depth in meters
German	Planet	1912	9,789
German	Emden	1927	10,791
Dutch	Snellius	1930	10,160
American	Cape Johnson	1945	10,498
Danish	Galathea	1951	10,628

The Emden figure of 10,791 meters was the result of a spurious return signal, and therefore could not be accepted as a valid sounding (Hess and Buell, 1950). The sounding was made on a traverse nearly parallel to the axis of the trench using a non-directional echo sounder. In the sounding of the Japan Trench, a depth of 10,907 meters was recorded by the U. S. S. "Ramapo", using an audible frequency echo sounder. Hess and Buell re-analyzed the "Ramapo" data and found the maximum depth of only 9,803 meters. Allowing an error of 110 meters due to the average error in reading the echo sounder, deviation in frequency of the power current and error in the correction tables due to variations in the velocity of sound in water of varying degrees of temperature, salinity and pressure, the "Galathea" figure of 10,628 meters remains to be one of the deepest soundings ever made to-date. If the original figure is finally accepted, its corrected value thus estimated, leaves the Mindanao Deep in the same position of eminence as before, namely, that of being one of the deepest spots in all oceans.

The first attempt of the "Galathea" to trawl and dredge the narrow sea bed of the Mindanao Deep yielded results which occasioned a flood of congratulatory messages from people in Europe, who kept themselves posted with the activities of the ship. On July 21, 1951, at about 1845 hours the trawl with the two dredges brought up animal life from a depth exceeding 10,000 meters, the deepest part of the combed area being 10,462 meters. Two lamellibranchs, which showed evidence of life when hauled aboard, eight actinians and several holothurians came up with the collecting gear to create biological history. Subsequent operations added several amphipods and tanaidarians which increased the total number of species collected from the area.

Following the collection of these deep-sea forms, there had been lively speculations on how the organisms came to settle upon the deep sea bed. Being sessile, these animals could not have been caught from anywhere else except from the bottom or the walls of the trench. It was difficult to believe, however, that the pieces of stones to which the organisms were found attached could have been scraped from the steep slopes and entrapped by the heavy collecting gear dragging at the rate of 1.5 to 2.0 knots. The wire was taut and parallel to the axis of the keel, and the boat methodically and patiently positioned directly over the trench while trawling. The presence of stones on the sea bed reveals, according to one of the "Galathea"

scientists, the results of recent seismic disturbances. The Mindanao Deep, being the epicenter of most of the earthquakes occurring in Eastern Visayas and Mindanao (Selga, 1931), must have a foundation that is geologically unstable. Consequently, some recent crustal displacements there might account for the peeling off from the steep slopes of the stones which, together with their load of sessile animals, rolled down to rest upon the soft stratum covering the sea floor. If this assumption is true, the animals collected indeed must have been able to adjust themselves to their new and unusual environment.

In the light of the work of the "Galathea" the concept of an azoic zone in the abyssal depths is now a thing of the past, although earlier, this has been dubiously disproved by the plankton collections taken from comparatively shallower depths using the self-closing Palumbo net.

That other forms of life do exist in the cold, disphotic and quiet waters of the Mindanao Deep was conclusively demonstrated by Dr. Claude E. ZoBell, one of the guest scientists aboard, who found viable bacteria from the deepest layer of water sampled. Collecting the samples under sterile conditions, the American microbiologist was able to culture them successfully under simulated *in situ* conditions. Most of the bacteria observed were rodlike in shape and of the nitrifying type. The presence of nitrifying bacteria in the water and mud samples indicates that the mineralization of organic matter occurs within the entire water column and in the layer of sediment immediately below it. This is considered significant, as more importance can now be ascribed to the known slow process of diffusion which returns the regenerated plant nutrients to the euphotic zone to maintain the tropho-dynamic equilibrium in the sea.

Mud samples were taken by the Pettersson grab and the Kullenberg core samplers. The only core sample collected was taken from a depth of 10,328 meters. The sample which was 75 cm. in length was preserved in a plastic glass tube for further study in Copenhagen. From the sample, they hope to find radioactive substances which may throw light on the rate of sedimentation. For isotope determination, several samples of bottom water were preserved in heat annealed glass ampules.

In collecting bottom samples and specimens, the Danish scientists were faced with the problem of determining just when the gear hit bottom. If more wire was payed out than

necessary, the excess length looped over and possibly fouled the gear and prevented it from functioning normally. As the damaged wire was hauled in to raise the gear, the sudden increase in the tension of the wire snapped it at its weakest point, thereby losing valuable equipment. The dynamometer, which recorded the varying tension on the wire, was of little use, as it failed to register easily the resulting slack in the wire when the gear touched bottom. This was due to the light weight of the gear compared with the weight of the wire out.

To meet this problem in future deep-sea operations, Dr. ZoBell hatched the idea of conducting glass ball breaking experiments. If a gear carried a glass ball which was made to explode when the gear hit bottom, the resulting sound could probably be heard in the hydrophone. Surprisingly, the experiments yielded results which, among other things, satisfactorily explained the crushing of several deep-sea reversing thermometers used in the hydrographic work. Of the 58 glass balls lowered at different times to depths ranging from 9,000 to 10,418 meters, 28 were broken, 22 water-filled and the rest unbroken. The discordant results taken from the balls lowered at the same level were attributed to the fact that the balls were not made of uniform quality. However, it should be noted that these glass balls withstood pressure at 6,000 meters in previous experiments.

The information gathered from these glass balls breaking experiments promises to be of outstanding importance in the design and use of deep-sea instruments. The American scientist explained the phenomenon of breaking by saying that the glass was compressed until it failed. When the ball finally broke, water must have rushed suddenly to fill the void space, thus creating a region of greatly reduced pressure in the vicinity of the broken ball. The accompanying equalization in hydrostatic head resulted in what he termed an implosion. The penetration of water into some of the unbroken balls was explained by saying that it might have been due to some molecular phenomenon of an astonishing kind.

In the light of these experiments Dr. ZoBell's theory of implosion appears to be the only valid explanation for the pulverization of the glass of which the thermometers were made. The effect of the implosion was manifested by the caving in of the metal frames which held the thermometers in position.

A new concept on the behavior of oceanographic gear at subsurface depths was evolved when a bathysphere was sent down with a load of instruments, and returned with a record of its movements while in suspension in a mobile medium. With an inside diameter of about 22 inches, the metal ball was divided into two hemispheres flanged tightly together by closely spaced stud bolts. An aluminum frame of approximately two feet in width and eight feet in length was clamped to the wire a few feet above the shackle that linked the upper hemisphere with the end of the wire. In spite of the frame, a rotation of about 270 turns was recorded in one trial. One wing of the frame was bent, while the other had its distal end sliced off as if a sharp heavy knife had cut it. A maximum vertical displacement of about a meter was recorded.

On the basis of the bathysphere data, it may now be assumed that oceanographic gear lowered to great depths by a steel wire, composed of twisted strands, behaves in a similar manner. Thus, the number of failures experienced by the "Galathea" in her deep-sea operations can be ascribed to this fact.

One important aspect of the work of the "Galathea", which will influence greatly fishery researches of the future, pertained to organic productivity measurements. Outstanding in the principles involved and of far-reaching significance in the assessment of the fertility of surface waters, organic productivity measurements appear to afford the only direct approach to a quantitative study of the food cycle in the sea. With the method of using an artificially radio-activated carbon as a tracer in organic productivity studies, oceanography comes close to the threshhold of being able to assess fish production in terms of available plant nutrients in sea water. Where before the routine analysis of dissolved nutrient salts in sea water merely gave an indirect index to the fertility of a given area, now a direct correlation exists between hydrographic and biological data.

REMARKS AND RECOMMENDATIONS

On the whole, the work of the "Galathea" may be regarded as the starting point in unraveling the mysteries shrouding the Mindanao Deep. A repeated survey of the area with a reasonable interval of time may yield information important to the understanding of the capricious climatic changes around us. Now unknown to anyone, it may be playing an important role in developing the oceanographically interesting pattern of

oceanic circulation in the Western Pacific. Given active support by the public, which in Denmark made possible the "Galathea" Expedition, a similar undertaking, sponsored by the Government, can add to our knowledge of the Mindanao Deep, which lies sprawled just behind our backdoor.

At the behest of the writers, Dr. Bruun, head of the scientific staff, gave his views on problems which he thought should engage the attention of marine investigators in the Philippines. He specifically suggested the statistical study of important fisheries however faulty the data might be in the beginning. For the census of fish populations, tagging experiments should yield first-hand information on the state of our fisheries. This will ultimately lead into an understanding of conservation problems.

He would recommend the establishment of a deep-sea research laboratory preferably in a protected town in Surigao.

REFERENCES

HESS, H. H., and M. W. BUELL, Jr. 1950. The greatest depth in the oceans. Trans. Sm. Geo. Union. 31 No. 3: pp. 401–405. 1950.

SELGA, MIGUEL. 1931. The deeps of the Philippines. Pubs. of the Manila Obs. 3 No. 8:189–195.

THE NEW HASANG MODERNO, A FISH CORRAL USED IN THE PHILIPPINE WATERS [1]

By Santos B. Rasalan

Of the Bureau of Fisheries, Manila, Philippines

TWELVE TEXT FIGURES

ABSTRACT

Of the many types of fish corrals used for catching fish in sheltered waters of the Philippines, the new *hasang moderno* which was developed and operated at Kalibo, Capiz, during the summer months of 1950, is considered to be the most effective. Like the other fish corrals, this gear consists of a series of enclosures with a leader, four wings, and three entrances or gates. It differs, however, from the other types in that the terminal pond is located at the same axis with the leader on the outer side of the semicircular enclosure which it superimposes. The multiple entrances, together with the leader and the series of enclosures, effectively prevent the escape of the fish which are intercepted.

The method of construction and operation of the new *hasang moderno* is described in this paper and is fully illustrated. Complete specifications of this gear are also discussed.

Fish corrals are guiding barriers which are set in different depths of sheltered waters to intercept fishes during their migration, impounding them into the collecting chamber where they are caught. They are constructed in various styles, ranging from a simple ambulatory pound, with or without a leader, to a more or less complicated structure consisting of a series of enclosures, gates, wings, and a leader which are so arranged as to effect an easy entrance but difficult exit for the intercepted fish.

Of all the fish corrals operated in the Philippines, the *hasang moderno* has been considered the most effective. Based on the description of Talavera and Montalban (1932), this fish corral (fig. 1) consists of three gates, *m, se,* and *s'e';* four wings, *w;* a leader, *l;* a series of four enclosures; a heart-shaped terminal pound, *tp,* constructed at the end of one of the arms of the semicircular enclosure, *si,* which is superimposed by a triangular compartment, *tc,* and a triangular forechamber, *fc,* called *hasang,* from which the name of the fish corral was

[1] Contribution of the Philippine Delegation to the Third Meeting of the I.P.F.C. at Madras, India, February 1–16, 1951.

derived. This fish corral has undergone improvement, with simpler design and construction giving rise to the new hasang moderno. This new hasang moderno was first operated in Kalibo, Capiz, from April 1, 1950 to October 15, 1950. The

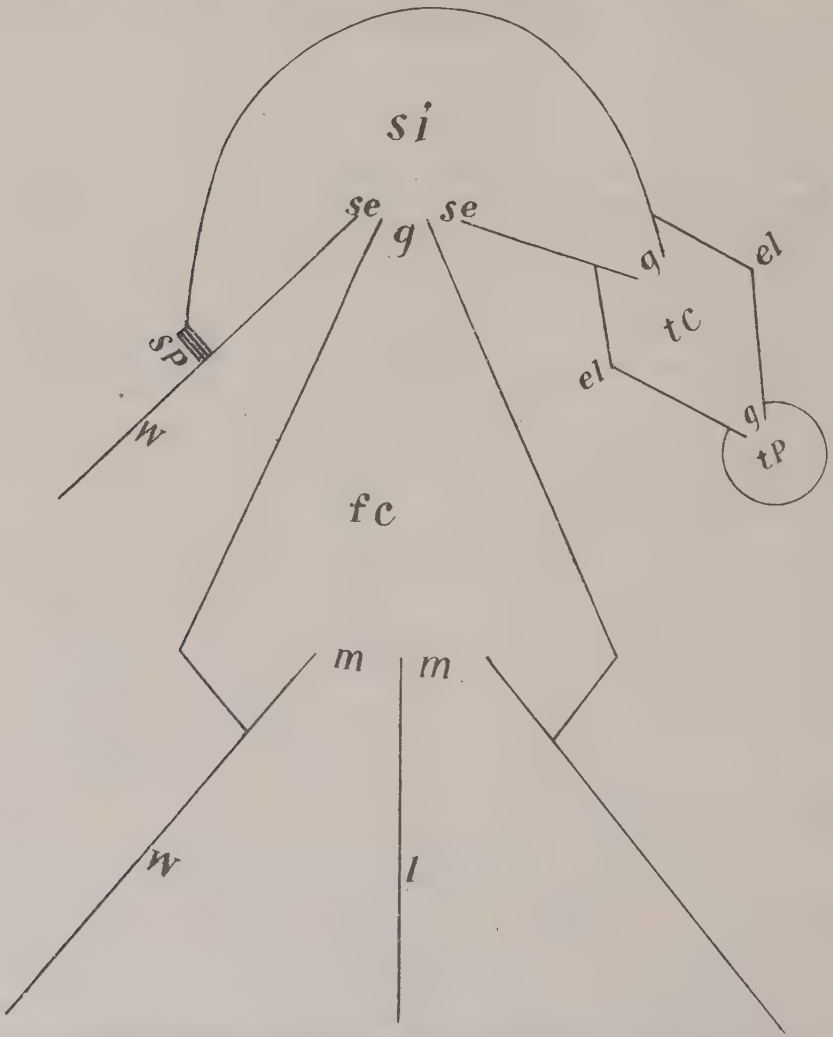
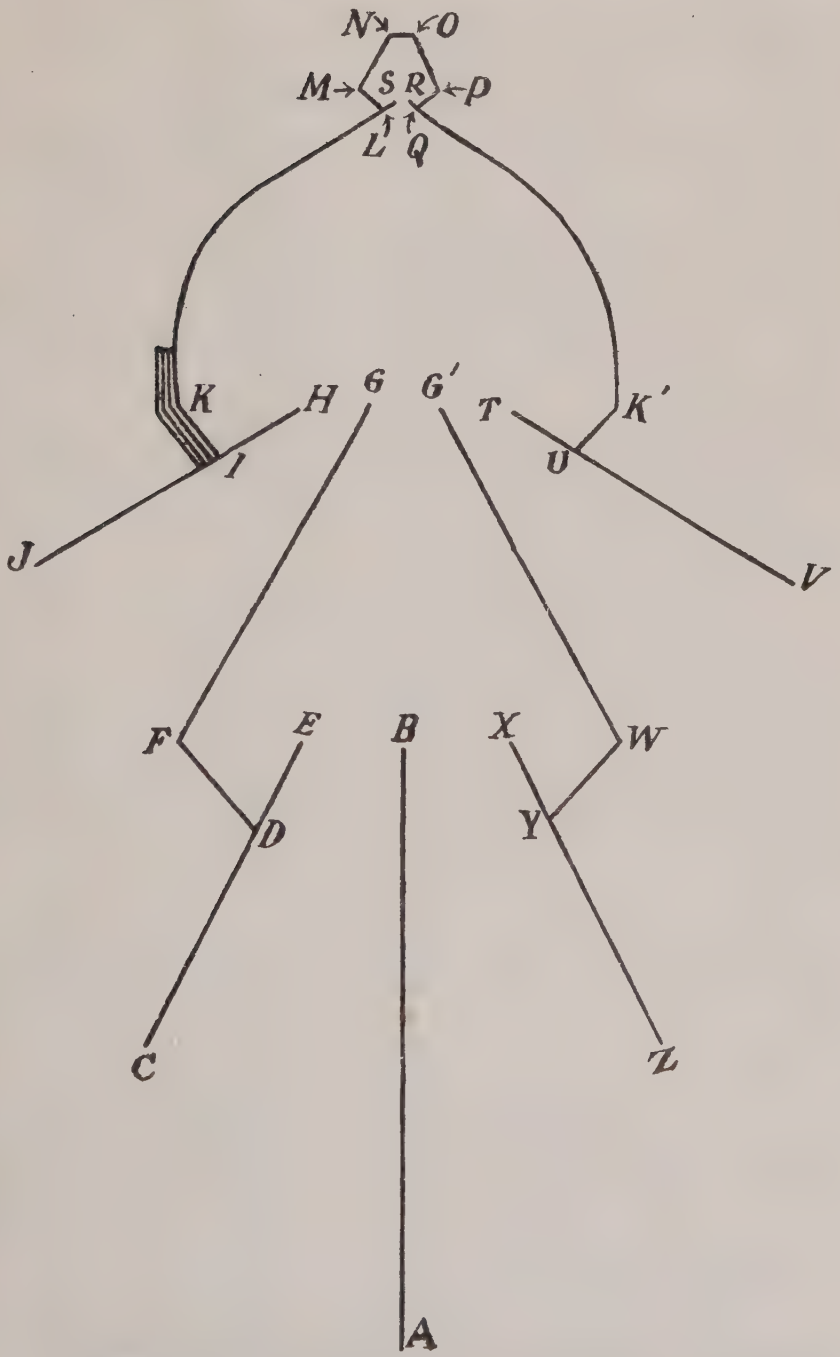


FIG. 1. Hasang moderno (1932) diagrammatic: *g*, entrance; *l*, leader; *m*, gate; *w*, wing; *el*, elbow; *fc*, forechamber; *se*, side gate; *si*, semicircular compartment; *tp*, terminal pound.

operation was very successful to the extent that it attracted the attention of other fish corral operators, living not only near that fishing ground, but also in other parts of the Philippines, who later on adopted its use.



2. The new hasang moderno: *AB*, leader; *CE* and *XZ*, lower wings; *JH* and *TV*, upper wings; *EX*, *GH*, and *G'T*, gate; *DFGG'WY*, forechamber; *IKSRK'UT*, semicircular enclosure; *LMNOPQ*, terminal pound.

This paper presents a detailed description of the construction and operation of this new type of gear.

GENERAL DESCRIPTION OF THE GEAR

Fig. 2 is the plan of the new hasang moderno. Like its prototype, it consists of a leader, *AB;* two lower wings, *CE* and *XZ;* two upper wings, *JH* and *TV;* three gates, *EX, GH, G'T;* a forechamber, *DFGG'WY;* a semicircular enclosure, *IKSRK'UT;* and a terminal pound, *LMNOPQ.* The terminal pound, however, is located at the same axis with the leader at the outer side of the semicircular enclosure which it directly superimposes.

Based on the new hasang moderno owned by Mr. Cirilo Lacerna Jr., a graduate of the Philippine Institute of Fisheries Technology, operated at Kalibo, Capiz, which may be taken as a typical sample of this fish corral, the measurements of the different parts are as follows:

The leader is 240 meters long and the lower and upper wings are 44 meters and 42.5 meters long, respectively; the forechamber is 44.60 meters at its greatest width, *FW,* and 31.55 meters long, measured from the lower gate to the entrance to the semicircular enclosure; the latter is also 44.5 meters wide, *KK',* and 26.9 meters long, measured from midpoints of *GG'* and *SR;* while the terminal pound is 8.9 meters wide, *MP,* and 8.2 meters long measured from the mouth of the semicircular enclosure *SR* to side *NO.*

The gear is invariably set in sheltered waters along sandy or muddy beds which are free from corral reefs. These waters are supposed to be across known paths of fishes ranging in depth from 5 to 12 fathoms. Usually waters which beds are higher than their immediate surroundings are preferred.

The fences of the fish corral consist of frames and bamboo screens. The frames (fig. 3) consist of well-seasoned bamboo posts and braces. The bases of the posts are pointed and triangular holes are bored just below the nodes for the water to fill in the internodes, thus making it easy to plant them at the muddy bottom.

The bamboo screens consist of bamboo splits laced together at regular intervals with either threaded coconut inflorescence bud scales, rattan (*Calamus* spp.) or *hagnaya* (*Polypodium*

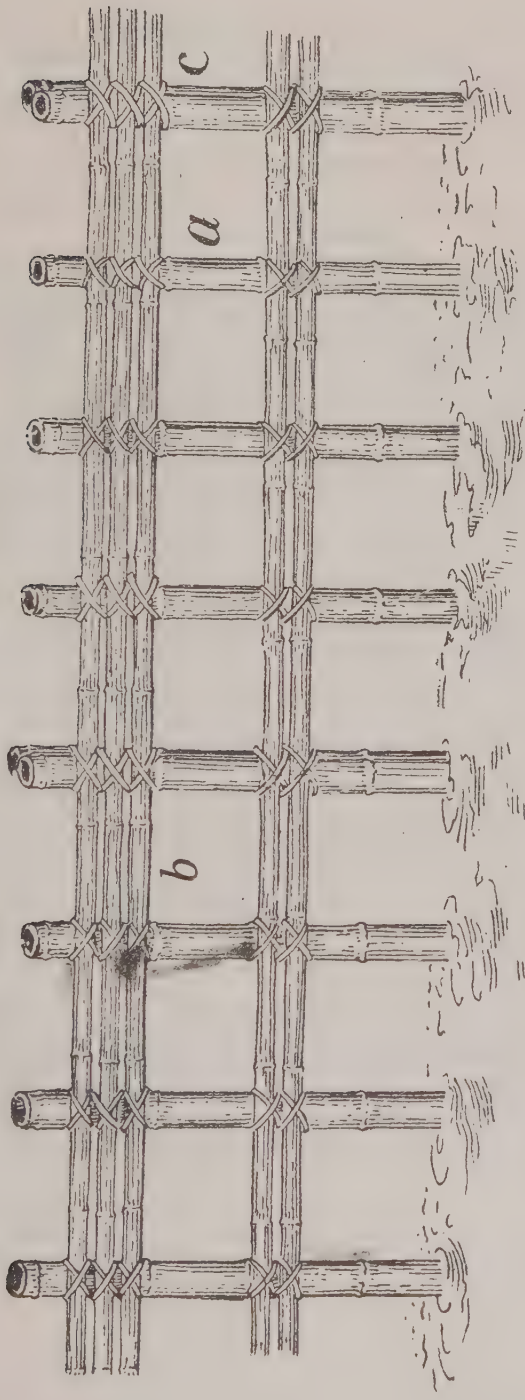


FIG. 3. The uprights or frames; *a*, uprights; *b*, braces; *c*, a bundle of two bamboos.

spp.). Figs. 4 and 5 show the appearance of the bamboo screens and Table 1 gives their specifications in the different parts of the fish corrals. As the depth of the bamboo screens are shallower than the depth of the water, two or more are joined end to end to fence the entire column of water. The screens for the leader, wings and forechamber have slats

TABLE 1.—*Specifications of the new hasang moderno operated at Kalibo, Capiz.*

Parts					Bamboo screens			Remarks
Name	Symbols	Length in meters	Number of posts	Number of screens	Size of screens in meters (depth x length)	Size of of splits in meters (width x (length)	Distance between splits in meters	
L E A D E P	AB1 AB2 AB3 AB4 AB5 AB6 AB7	30 35 35 35 35 35 35	6 7 7 7 7 7 7	12 14 14 14 14 14 14	4.2×5 4.0×5 3.8×5 3.5×5 3.2×5 3.2×5 3.0×5	0.02×4.2 0.02×4.0 0.02×3.8 0.02×3.5 0.02×3.2 0.02×3.0 0.02×3.0	0.12 0.12 0.12 0.12 0.12 0.12 0.12	Excepting A1 two rows of bamboo screens are set on the framework overlapping each other by 10 cm.
Total		240	28					
W I N G S Total	—DC —DE YZ —XY —JI —NU —UV —TU	29 15 29 15 28.5 14 28.5 14 171	6 3 6 3 6 3 6 3 40	12 6 12 6 11.8 6 11.8 6 71.6	4.2×5 4.5×5 4.2'5 4.5×5 4.7×5 5.4×5 4.7+5 5.4×5	0.013×4.2 0.013×4.5 0.013×4.2 0.013×4.5 0.013×4.7 0.012×5.4 0.013×4.7 0.012×5.4	0.83 0.83 0.83 0.83 0.12 0.42 0.12 0.042	Two rows of bamboo screens are set on the framework overlapping each other by 10 cm.
Forechamber	DF FG YW WG'	12.5 30.25 12.5 30.25	4 10 4 10	4 10 4 10	4.5×6.25 4.9×6.15 4.5×6.25 4.9×6.15	0.013×4.5 0.013×4.9 0.013×4.5 0.013×4.9	0.83 0.83 0.83 0.83	Two rows of bamboo screens are set on the framework overlapping each other by 10 cm.
Total		85.50	28	28				
Semicircular enclosure	IK KL LS RQ QU	10 36.47 4 4 46.47	3 12 2 2 15	4 14 2 2 18	6×5 6×5.3 6×4 6×4 6×5.3	0.012×6 0.012×6 0.012×6 0.012×6 0.021×6	0.42 0.42 0.01 0.01 0.42	Two rows of bamboo screens are set on the framework overlapping each other by 10 cm.
Total		98	34	440				

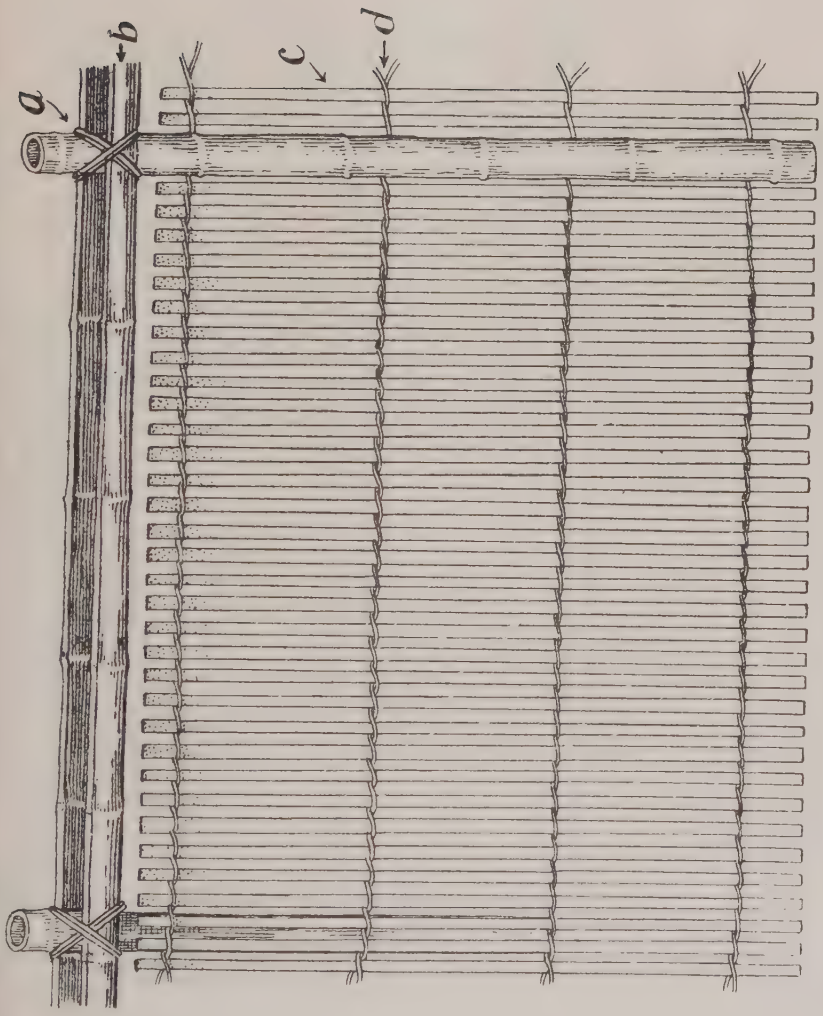


FIG. 4. A diagrammatic presentation of a portion of the terminal pound and semicircular enclosure showing the lacing of the slats; *a*, uprights; *b*, brace; *c*, bamboo screen; *d*, lacing.

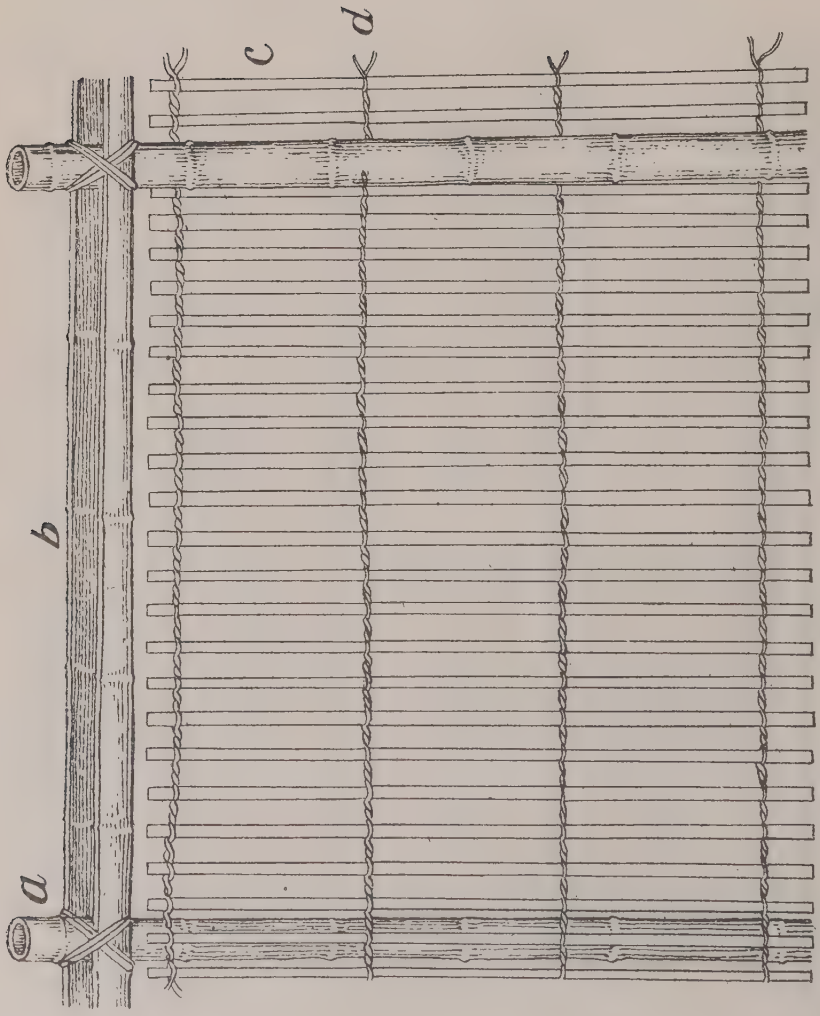


FIG. 5. A diagrammatic presentation of a portion of the bamboo mating used at the wings, and forechamber and leader showing how the slats are laced: *a*, bamboo post; *b*, brace; *c*, bamboo screen; *d*, lacing.

Terminal pound	LM	2.8	2	3	6×2.5	0.012×6	0.01	Two rows of bamboo screens are set on the framework overlapping each other by 10 cm.
	MN	8.5	4	6	6×4.3	0.012×6	0.01	
	NO	3.5	2	3	6×3.7	0.012×6	0.01	
	OP	8.5	4	6	6×4.3	0.012×6	0.01	
	PQ	2.8	2	3	6×2.5	0.012×6	0.01	
Total		26.1	14	21				

Gates and entrances	—EB	6.5	A bamboo bridge is constructed above each gate and entrance.
	—BX	6.5	
	—NG	3.2	
	—GT	3.2	
	—GG	4.25	
	—RS	0.5	

coarser than those for the semicircular enclosure and terminal pound.

The screens are grouped according to the parts of the fish corral where they are intended to be set. Those that go together are joined lengthwise, and then rolled like mats to facilitate the handling and placing along the framework of the fish corral.

The setting of the fish corral is done after the fishing ground has been carefully mapped out, and all materials for the frame and screens have been prepared.

CONSTRUCTION AND SETTING OF THE FISH CORRAL

The outline-plan of the fish corral (fig. 2) is carefully laid or plotted by using imaginary lines and temporary stakes. The leader is laid perpendicularly to the direction of the current or the shoreline. Its length depends upon the distance of the corral to the shore. Generally, the end of the leader reaches very near the shoreline. It is believed that the longer the leader, the more fishes are intercepted and guided into the collecting pound of the gear. This setting requires the services of the fish-corral-master fisherman, who directs several good divers and other hands. The planting of the posts is done during low tide. Guide posts are first planted: anterior and posterior ends of the leader and wings, then the ends and corners of the different chambers. The planting of the other posts follows by setting them at two meters apart at the semicircular enclosure and terminal pound; three meters interval at the forechamber; and 5 meters between them at the wings

and leader. Care is taken so as to make them stand perpendicularly to the water. To strengthen the hold of the corral at the bottom and to prevent the posts from reclining due to wind and wave action, a bundle of two to four bamboos (fig. 3*c*) is used for every fourth post. Two to four lines of bamboos are braced to connect each pole just above the bamboo screens. The whole set of the bamboo poles constitute the framework of the fish corral.

The setting of the bamboo screens follows the completion of the frame. As in the setting of the posts, a stone weight of about 15 kilos is tied at the lower end of every rolled screen to keep it standing erect close to the frames when sank. The screen is unrolled little by little and tied with the rattan splits, hagnaya, or threaded coconut inflorescence bud scales to the framework. This procedure is repeated until all the screens are set to the different parts of the fish corral.

The setting of the screens is usually begun with the terminal pound followed by the semicircular enclosure, then the upper wings, forechamber, lower wings, and lastly, the leader. This order is followed because, often times, fishes begin to enter the enclosures as soon as they are set.

Unless destroyed by gales or typhoons, the hasang moderno may last from six to ten months. Its upkeep, however, requires periodical changing of the screens whenever they become weak or when they need cleaning and drying. Hence, there must be a reserve of at least one-half of the total number of screens needed in the fish corral during the season. When the season is over, all the screens are removed, leaving the framework in the water to be used again during the next season. The screens are scrubbed, dried and the weak slats changed and stored for the next season.

THE NETS

There are two nets used to catch the fish that enter the fish corral. One of them is the scoop seine (*sigin*) used to collect fishes at the semicircular enclosure. The other, the shrimp net, is used at the terminal pound.

Fig. 6 is a diagrammatic structure of the scoop seine and Tables 2 and 3 give its specifications. It consists of a bunt (fig. 6*A*, *B*) flanked by two wings (fig. 6*C*, *D*) hung on a 27.13 meters head rope, 22.56 meters foot rope and 12.19 meters breastline. Each wing is made of 9-thread cotton twine net-

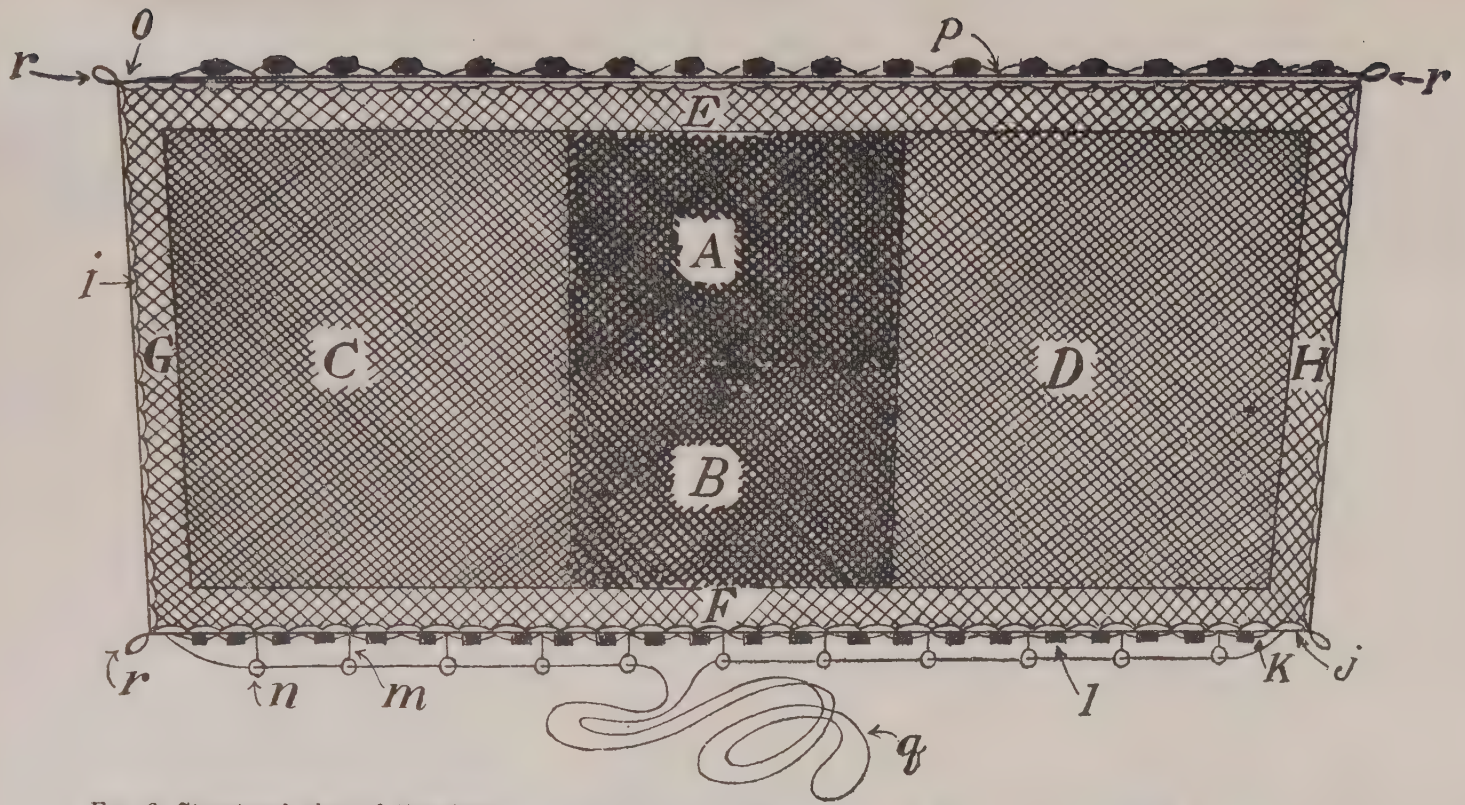


FIG. 6. Structural plan of the sigin: *A* and *B* bunt; *C* and *D*, wings; *E*, *F*, *G* and *H*, selvages; *i*, breast line; *j*, secondary lead line; *l*, lead weight; *k*, primary leadline; *m*, bridle; *n*, ring; *o*, secondary floatline; *p*, primary floatline; *q*, pursing rope; *r*, eye splice.

TABLE 2.—*Specification of the seine (sigin)*

Parts	Symbols	Materials: Kind	Materials: Twine number	Size of meshes stretched	Horizontal	Meshes deep	Strip	Remarks
Bunt	—A	cotton twine	12	2.24	312	500	1	Nettings joined mesh to mesh
	—B	cotton twine	9	2.54	300	300	1	
Wings	—C	cotton	9	2.54	573	800	1	Nettings joined mesh to mesh
	—D	cotton	9	2.54	573	800	1	
S	E	cotton	36	5.72	7	488	1	Outer edges of bunt and wings are joined to the selvages 4 meshes of the former to every mesh of the latter and then laced by a 26-thread cotton twine to the hanging line.
E	F	cotton	36	5.72	7	407	1	
L	G	cotton	36	5.72	7	220	1	
V	H	cotton	36	5.72	7	220	1	
A								
G								
E								

TABLE 3.—*Ropes and other accessories of the seine.*

Parts	Materials	Size in cm.	Length in m.	Number of pieces	Remarks
Primary float line	Manila rope	0.91 dia.	27.13	1	Where 70 floats are tied at 30.48 cm. distances.
Secondary float line	Manila rope	1.58 dia.	27.13	1	Where the lacing line of selvage are hung.
Breastline	Manila rope	1.58 dia.	12.19	------	Where the lacing line on width is hung.
Primary leadline	Manila rope	0.91 dia.	22.56	1	Where the lacing line of the cotton selvage is hung.
Secondary leadline	Manila rope	1.58 dia.	22.56	1	Where the lead weights are tied at 35.56 cm. distances.
Pursing rope	Manila rope	1.27 dia.	50	1	Each end is tied to the end of the primary leadline.
Briddle line	Manila rope	0.91 dia.	0.46	62	Distributed along primary leadline 45.72 cm. apart.
Floats	Soft wood	4 dia.	7.62	70	Equally distributed along the primary cork-line, 30.48 cm. far apart.
Sinkers	Lead	4 ounces	--------	62	Equally distributed along the primary leadline 35.56 cm. far apart.
Rings	GI	.6×7 dia.	--------	18	

ting of 2.54 centimeters mesh-stretched, 573 meshes wide and 800 meshes deep. The bunt is composed of two nettings, the upper portion of which is 312 meshes wide and 500 meshes deep, 2.24 centimeters mesh-stretched and made of 12-thread cotton twine; while the lower portion is a 9-thread cotton twine netting, 2.54 centimeters mesh-stretched, 312 meshes wide and 300 meshes deep. These are joined together mesh to mesh.

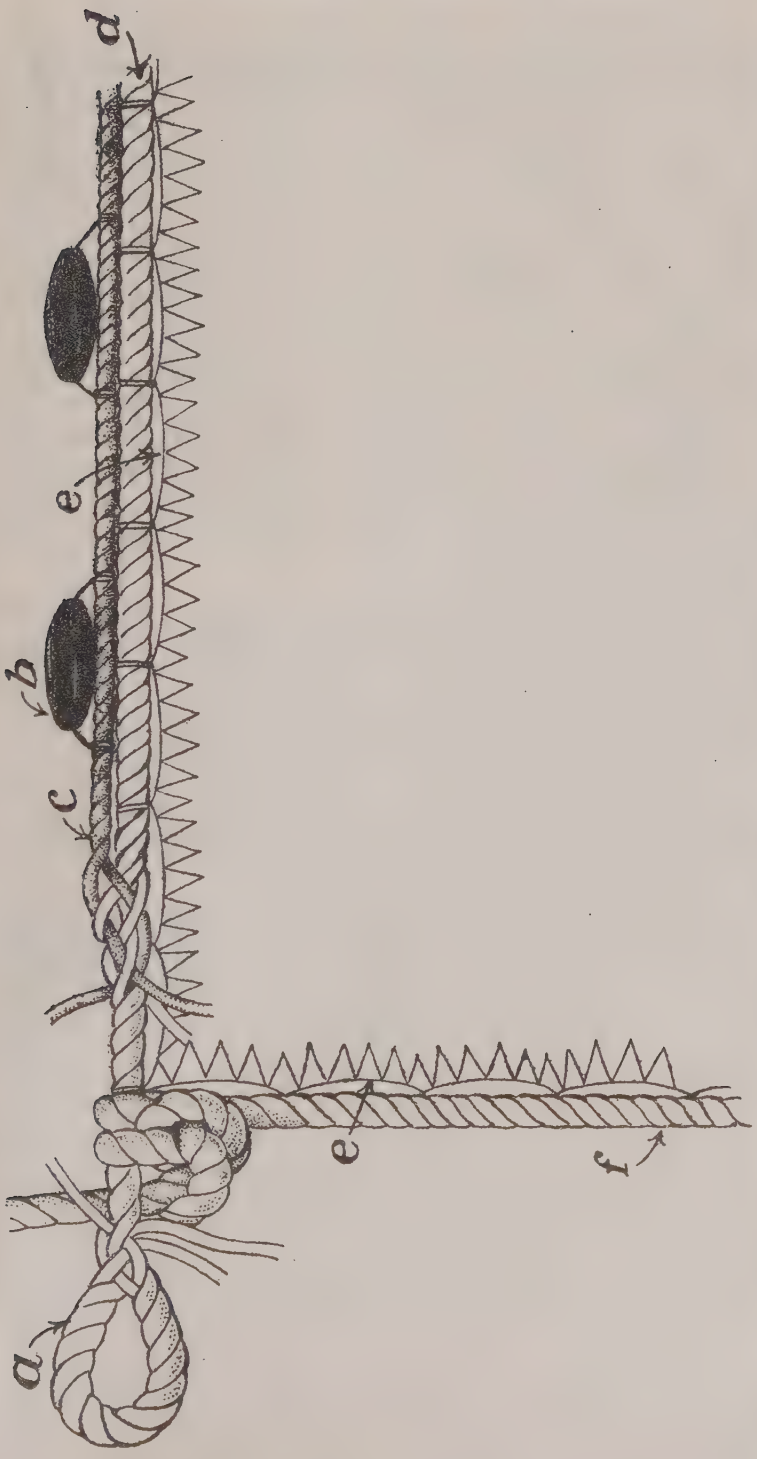


FIG. 7. A portion of the headline; *a*, eye, splice; *b*, float; *c*, primary floatline; *d*, secondary floatline; *e*, lacing line; *f*, breastline.

The selvages (fig. 6*E, F, G, H*) of coarser nettings are made of 36-thread seine twine, being 5.72 mesh-stretched and joined with the wings and bunt with a ratio of one to every four meshes. The selvages are seized by a 9-thread twine and hung to the secondary corkline, breastline and secondary leadline. Each end of the hanging line is an eye-splice (fig. 6*r*) of 7.62 centimeters diameter. A pull rope is tied to each of these eye-splices during the fishing operation. The ends of the purse line (fig. 6*g*) are spliced on the ends of the secondary leadline.

Fig. 7 shows a portion of the corkline. Each float is 7.62 centimeters long and 4 centimeters at its greatest diameter. The floats are tied along the primary floatline (fig. 7*c*) at 30.48 centimeters intervals. Sixty-two lead weights (fig. 6*l*), each weighing four ounces are strung to the leadline at intervals of 35.56 centimeters. In operation, two additional stone weights of 40 pounds each are tied to each end of the leadline to facilitate the sinking of the net.

The primary corkline and the primary leadline are spliced to the secondary corkline and secondary leadline, respectively.

Fig. 8 is the diagrammatic presentation of the shrimp net. It is in the form of an isosceles trapezoid and made of several pieces of sinamay cloth sewed together. This is hung to a Manila rope, 1.27 centimeters in diameter, with 40 per cent slack by a 9-thread cotton twine. The finished shrimp net is 7.74 meters and 3.43 meters on its parallel sides, while each of the nonparallel sides is 8.43 meters.

Like the scoop seine, each end of the hanging line is an eye splice (fig. 8*b*) where the pull rope is tied during the operation. On the midpoints of each of the nonparallel sides and ends of the longer parallel side are tied GI rings (fig. 8*c*) which are threaded into the gliding rope when the net is shot and hauled in at the terminal pound.

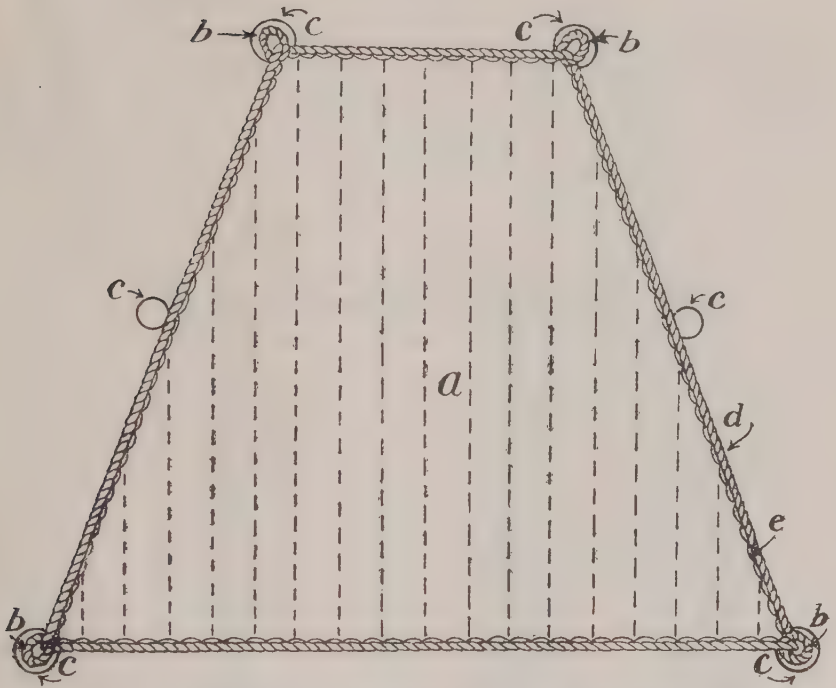


FIG. 8. A diagrammatic presentation of the structural plan of the shrimp net (not drawn to scale): *a*, sinamay cloth; *b*, sling; *c*, G. I. rings; *d*, hanging line; *e*, lacing line.

The following materials enter into the construction of the shrimp net: 87.47 meters × 1 meter sinamay cloth, 30 meters Manila rope × 1.27 centimeters diameter, 4 pieces GI rings 0.8 cm. × 7.62 cm. diameter, and 50 meters cotton twine 9-thread medium laid.

THE BOATS

Two boats are used in the fishing operation. The bigger boat (fig. 9) is used to transport the fishermen and nets to and from the fish corral, while the smaller one is used to carry the catch from the fish corral to the shore. The bigger boat is an ordinary dugout, 14 meters long, 1 meter wide and 0.54 meter deep, with one wooden planking on each side. An outrigger is provided only on the port side of the dugout, so that it can be brought close to the fence of the fish corral.

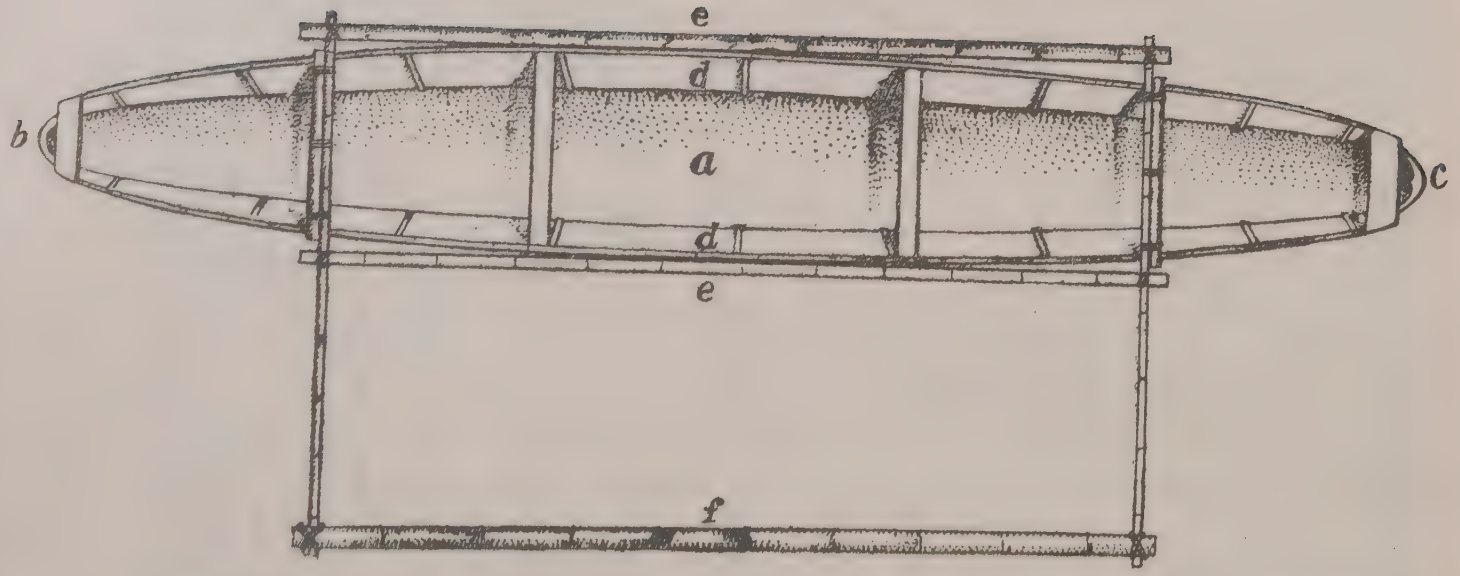


FIG. 9. Top view of the main boat; *a*, hallow keel; *b*, bow; *d*, wodden planking; *e*, bamboo for oar-locks; *f*, outrigger.

The small boat (fig. 10) is flat-bottomed with pointed bow and no outriggers. It is about 3.84 meters long, 0.7 meter wide and 0.49 meter deep. A piece of bamboo is tied on top of each gunwales (fig. 10*a*) where the oars are tied when the boat is rowed. Like the bigger boat, the depth and deck space are increased by planking on each side.

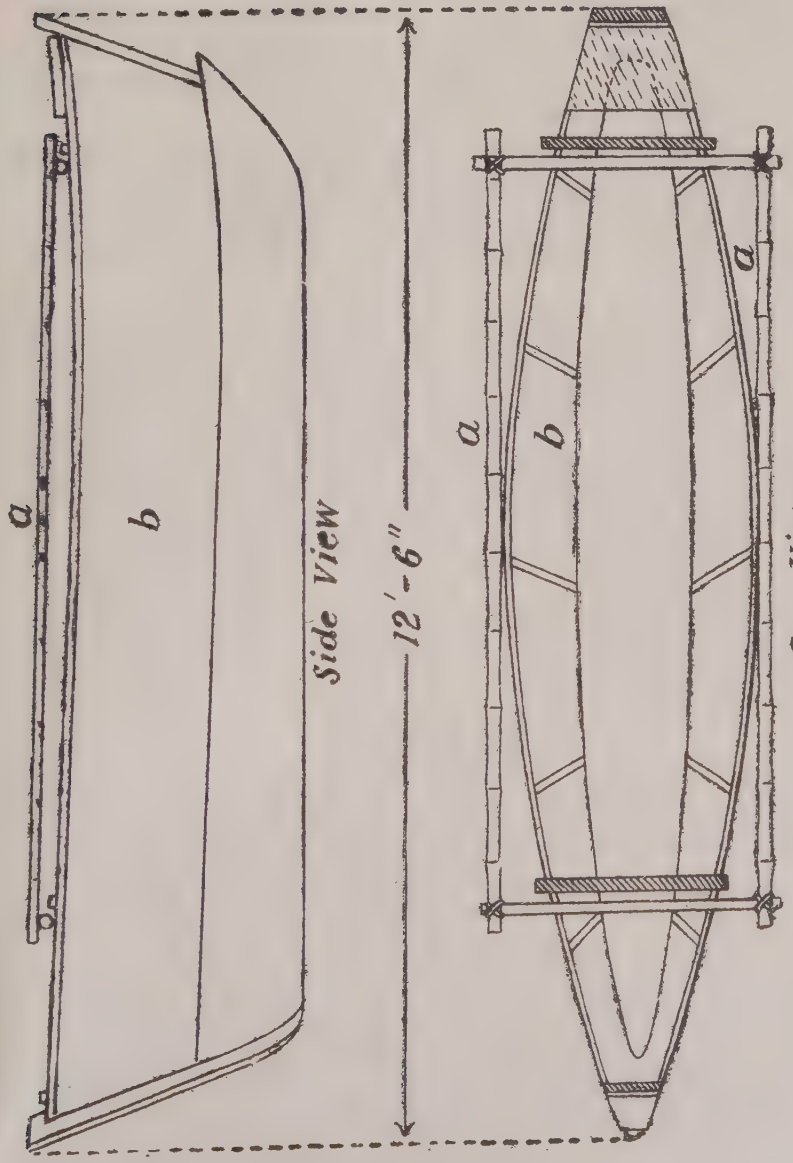


FIG. 10. The lateral and side views of the small boat; *a*, bamboo oarlocks; *b*, planking.

THE CREW: THEIR DUTIES AND PARTICIPATION IN THE CATCH

A complement of 16 fishermen is needed to operate the fish corral: one master fisherman, two assistant master fishermen, four divers and nine ordinary fishermen. The master fisherman directs all the work, including the construction, maintenance and fishing operations of the fish corrals, and the marketing of the catch. The divers do the construction and repair of the gear, while the ordinary fishermen act as general utility men. All, however, help in the catching of the fish inside the semicircular enclosure and the terminal pound.

The splitting of the bamboos, cleaning and lacing or weaving of the slats of the bamboo screens are done by contract labor. The expenses incurred are considered as a part of the costs of operation which are deducted from the gross sales before the profit is declared.

The members of the crew are paid on the profit-sharing basis. The cost of operation, which includes the expenses incurred for the construction of the bamboo screens, taxes, licenses, twines, rattan splits and other supplies needed in the repair of the fish corral and accessories, is deducted from the gross sales and the remainder is divided into two equal parts. One part goes to the owner of the fish corral while the other part is divided into 19 shares distributed as follows:

1 Master fisherman	2	shares
2 Assistant master fisherman	1½	shares each
4. Divers	1¾	shares each
9 Ordinary fishermen	1	share each

FISHING OPERATION

The catching of the fish that enter the terminal pound and the semicircular enclosure is done during the early dawn so that the catch may be brought to the market in time to be sold in the morning. Hauling may also be done at night during the dark phase of the moon, especially during ebb time, to catch shrimps and other fishes with the use of light.

Seven men consisting of one assistant master fisherman and six ordinary fishermen are needed to operate the shrimp net in the terminal pound. Four stone weights of two kilos each are tied to the four corners of the net. Then gliding ropes are tied at points *e* and *f* of sides AC and BD (fig. 11) respectively, and perpendicularly down to the base of the frame. To this,

each ring (fig. 8*c*) is threaded by the corresponding gliding rope thus allowing the net to glide up and down when setting and hauling. They also serve as supports of the net when set, and keeping it from being drifted by the current.

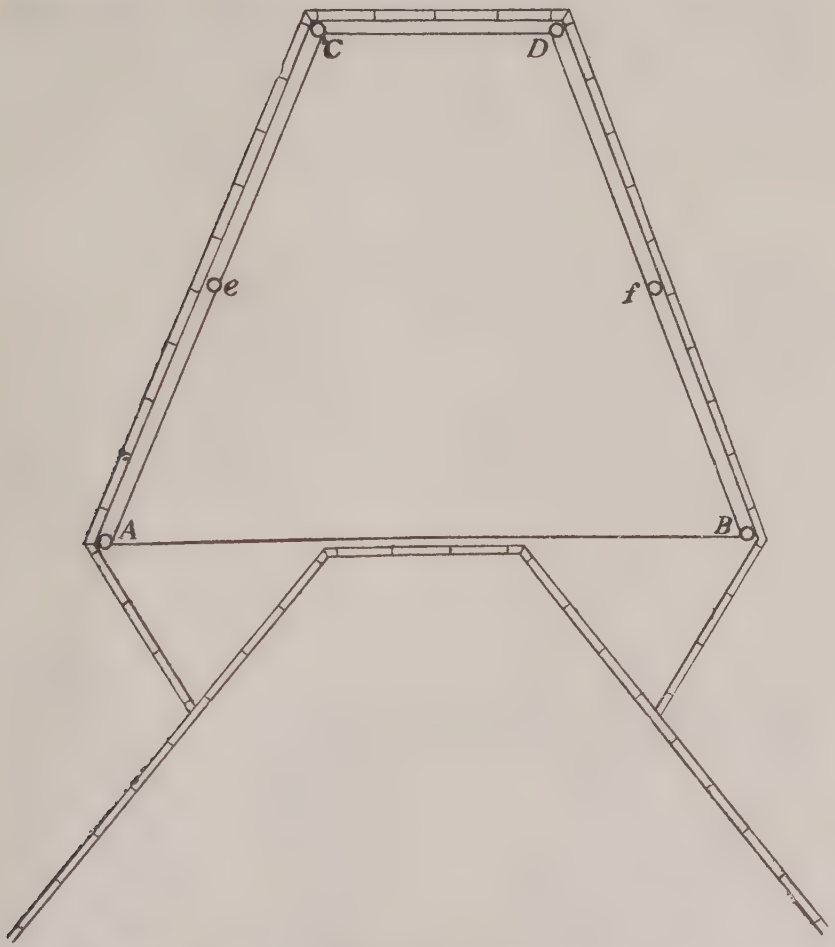


FIG. 11. The terminal pound showing how the shrimp net is laid out during fishing operation. *A B C D* the net.

In setting the net, the eye splices (fig. 8*b*) are each tied down with a pull rope while the rings are threaded by the respective gliding ropes. The corners are tied with a stone weight of two kilos each. Corners C and D (fig. 11) are brought near points *e* and *f* and dropped to the bottom. The other portion of the net (fig. 11:AB*fe*) is also dropped. This

is done to prevent the covering of the fish inside the pound by the net. Then, the pull ropes at C and D are pulled to spread the net in such a way that the bottom of the terminal pound is covered entirely. After a while, it is raised to scoop the catch. This operation is performed several times.

Fig. 12 is a diagrammatic presentation of the setting and hauling of the net at the semicircular enclosure. Nine fishermen, including the master fisherman and one assistant master

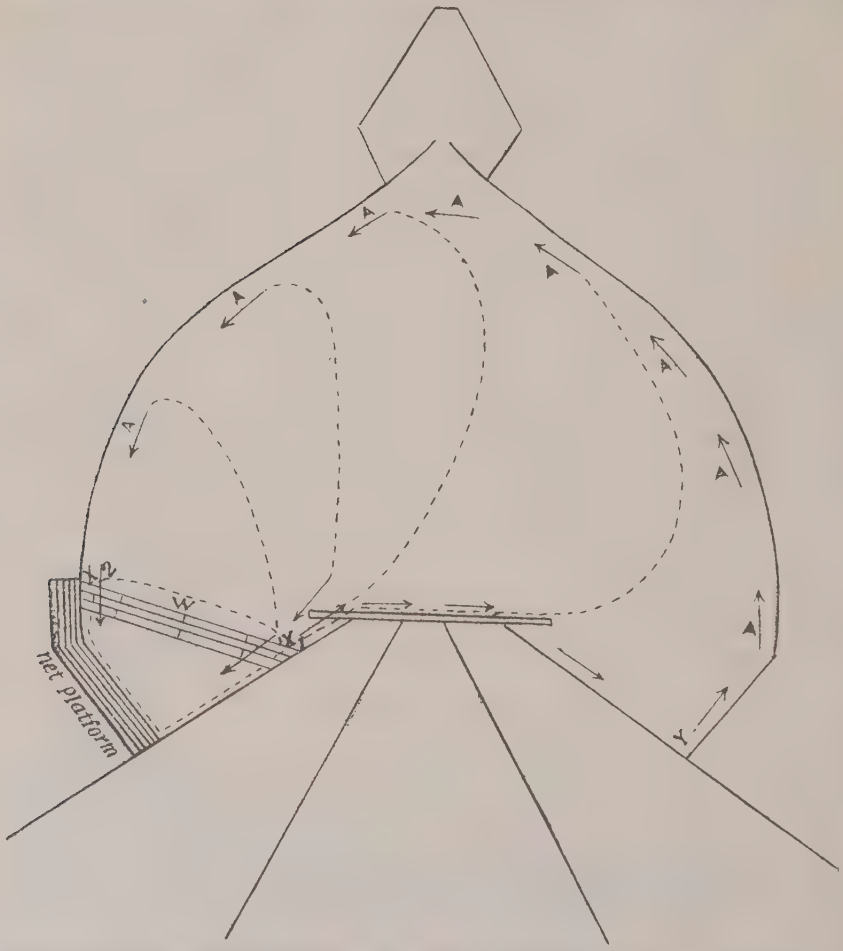


Fig. 12. A schematic drawing showing the catching of fish at the semicircular enclosure.

fisherman, are needed to operate the scoop seine. The net is dropped at the bamboo bridge (fig. 12*W*) at X_1 and then extended to Y thus transforming it into a curtain closing the

entrance and gates of the fish corral. The end, at Y, is dragged close to the fence following the direction as indicated by arrow A of fig. 12 until X_2 is reached. This movement is followed by four divers who see to it that the leadline touches the sea-bed and the fence of the enclosure. Three men on the bamboo bridge hold the floatline while the leadline is brought close to the fence below the net platform and the bottom of the net is raised by pulling the pursed line, thus forming a sort of hammock. Here, the fishes are concentrated at the bunt where they are scooped and placed on the waiting banca. This operation is repeated several times.

THE CATCH

Table 4 is a list of the common fishes caught in the hasang moderno. Most of them are pelagic species which are found on a commercial scale during the season. Shrimps are also caught during the dark phase of the moon specially so when a lamp is used to attract them at the terminal pound.

The catches are sold either to fresh fish vendors, who go to the fish corral during hauling, or to wholesale buyers who are owners of salting plants. Direct icing of the catches is not practiced.

TABLE 4.—*Fishes caught by hasang moderno.*

English name	Local name	Scientiec name
Anchovies	Bolinao	*Stelephorus* spp.
Bañgos	Bañgus	*Chanos chanos.*
Barracuda	Batog	*Sphyraena* spp.
Big-eyed scad	Bocawan nga buca	*Selar crumenophthalmus.*
Cavalla	Ampalian	*Caranx* spp.
Do.	Maming	Do.
Do.	Balilin	Do.
Do.	Momsa	*Caranx sexfasciatus.*
Devil fish	Sunga	*Mobula* spp.
Drepane	Bayang	*Drepane punctata.*
Grouper	Lapu-lapu	*Epinephelus* spp.
Guitar fish	Sodsod	*Rhynchobatus djiddensis.*
Hair tail	Liwit	*Trichiurus haumela.*
Leather jackets	Salindato	*Scomberoides* spp.
Mackerel	Bulao	*Rastrelliger chrysozonus.*
Do.	Aguma-a	*Rastrelliger brachysomus.*
Moon fish	Habas	*Mene maculata.*
Pampano	Mariano	*Caranx* spp.
Shark	Pating	Galeidæ.
Skipjacks	Tulingan	*Katsuwonus pelamis.*

English name	*Local name*	*Scientivc name*
Spanish mackerel	Tangigue	*Scomberomorfis commersoni.*
Swordfish	Malasugi	*Xiphias gladius.*
Yaito tuna	Bantala-an	*Euthynnus* spp.
Yellow tuna	Tulingan	*Neothunnus macropterus.*

MISCELLANEOUS

Squid	No-os	*Loligo* spp.
Porpoises	Lumba-lumba	
Shrimps	Alamang	Atyidæ.

CAPITALIZATION AND CATCH OF A NEW "HASANG MODERNO" OPERATED AT KALIBO, CAPIZ, IN THE SUMMER MONTHS OF 1950

A. *Capitalization:*

1. *Equipment—*

One banca, 14 m. × 1 m. × 0.54 complete with outrigger on one side	₱250.00	
One banca, 3.84 m. × 0.7 m. × 0.49 m., flat bottom	50.00	
One ring net (sigin), 25.82 m. head rope × 12.19 m. breast line × 22.55 m. ground rope, complete with floats weights and pursing devices	1,405.00	
One shrimp net (sinamay), 7.75 m. × 3.43 m. × 8.43 m., complete with rings and pull ropes	50.00	
One scoop net with handle	5.00	
Eight pieces of oars	20.00	
Total for equipment		₱1,780.00

2. *Supplies—*

1,187 pcs. bamboos without spines, each at least 10 m. long	₱842.00	
350 pcs. bamboos, with spines at least 10 meters long	350.00	
2,050 pcs. split rattan	58.00	
15,000 pcs. coconut inflorescence bud scale sheaths	195.00	
1 roll Manila rope, ½" diameter	67.00	
Total for supplies		1,512.00
Grand Total		₱3,292.00

B. *Cost of operation:*

1. Licenses—for a year lease of the fishing ground	₱750.00
2. Taxes—	
Privilege tax	10.00
Sales tax—5 per cent of gross sale	503.75
3. Supplies—rattan, bamboos, twines, nettings, etc., needed for repairs	300.00
4. Labor—	
For splitting bamboos including cleaning of splits	45.00
5. For lacing bamboo splits into bamboo screens	350.00
6. For setting the fish corral	51.25
Total cost of operation	₱2,610.00

C. *Sales:* Total sales from April 1, 1950 to October 15, 1950.... ₱10,074.62

Months	Fish caught	Sales
April	2,649.00	₱2,560.20
May	5,170.75	3,146.32
June	5,107.00	1,350.26
July	1,747.50	769.31
August	560.80	537.70
September	1,033.00	815.36
October (1–15)	960.00	895.47
Total	17,288.05	₱10,074.62

REFERENCES

RASALAN, SANTOS B. New methods of fish capture in the Philippines. Bull. Fish. Soc. Phil. (1950) Vol. 1, Commemorative issue, Manila.

RASALAN, SANTOS B. Forms of fish corrals in the Philippines. Agricultural Weekly 1 Nos. 6, 7 and 8 (1952).

RASALAN, SANTOS B. Fishing gear commonly used in Philippine fishing. Philippine fisheries. A handbook prepared by the technical staff of the Bureau of Fisheries, Manila, 1952.

TALAVERA, F., and H. R. MONTALBAN. Fishing appliances of Panay, Negros and Cebu. Phil. Jour. Sci. 32 (1932) 465–466.

UMALI, AGUSTIN F. Deep-sea fishing in the Philippines. Dept. Agri. Com. Pop. Bull. No. 9 (1936).

ILLUSTRATIONS

TEXT FIGURES

FIG. 1. Hasang moderno (1932) diagrammatic: *g*, entrance; *l*, leader; *m*, gate; *w*, wing; *el*, elbow; *fc*, forechamber; *se*, side gate; *si*, semicircular compartment; *tp*, terminal pound.

2. The new hasang moderno: *AB*, leader; *CE*, and *XZ*, lower wings; *JH* and *TV*, upper wings; *EX*, *GH*, *G'T*, gates; *DFGG'WY*, forechamber; *IKSRK'UT*, semicircular enclosure; *LMNOOPQ*, terminal pound.

3. The uprights or frames: *a*, uprights; *b*, braces; *c*, a bundle of two bamboos.

4. A diagrammatic presentation of a portion of the terminal pound and simicircular enclosure showing the lacing of the slats: *a*, uprights; *b*, brace; *c*, bamboo screen; *d*, lacing.

5. A diagrammatic presentation of a portion of the bamboo mating used at the wings, forechamber and leader showing how the slats are laced: *a*, bamboo post; *b*, brace; *c*, bamboo screen; *d*, lacing.

6. Structural plan of the sigin: *A* and *B*, bunt; *C* and *D*, wings; *E*, *F*, *G* and *H*, selvages; *i*, breastline; *j*, secondary leadline; *l*, lead weight; *k*, primary leadline; *m*, bridle; *n*, ring; *o*, secondary floatline; *p*, primary floatline; *q*, pursing rope; *r*, eye splice.

7. A portion of the headline: *a*, eye splice; *b*, float; *c*, primary floatline; *d*, secondary floatline; *e*, lacing line; *f*, breastline.

8. A diagrammatic presentation of the structural plan of the shrimp net (not drawn to scale): *a*, sinamay cloth; *b*, sling; *c*, G.I. ring; *d*, hanging line; *e*, lacing line.

9. Top view of the main boat; *a*, hallow keel; *b*, bow; *d*, wooden planking; *c*, stern; *e*, bamboo for oar-locks; *f*, outrigger.

10. The lateral and side views of the small boat: *a*, bamboo oarlocks; *b*, planking.

11. The terminal pound showing how the shrimp net is laid out during fishing operation. ABCD the net.

12. A schematic drawing showing the catching of fish at the semicircular enclosure.

INDEX

A

ABLAN, GUILLERMO L., Two Philippine boring molluscs, 184; Lattice method of oyster culture, 189.
Acanthurus bleekeri, 111, 118
Acronurus, 75, 77, 78, 79, 81.
Agoot, 110, 114.
Aguma-a, 225.
Alamang, 226
Albacores, 72
Alectis indicus, 110.
  sp., 118.
Algae, blue-green, 52.
Alumahan, 113, 116, 118, 110.
Aluminum, 107
Ampalian, 225
Amphipoda, 77, 81.
Ampularia luzonica, 135.
Ampularid snail, 135.
Anas boschas, 121.
Anchovies, 225.
Anga, 1, 3, 51.
Anisoptera thurifera (Blanco) Merr, 125.
Ankal, 37, 41, 49, 53.
  fry, 40.
  sa muli, 41.
Anodontostoma chacunda, 111
Antigonia, 79.
Antigonidae, 78, 79, 80.
Apahap, 110, 113, 114, 109.
Api mavani, 185
Api-api, 185.
Apodes, 80.
Aquatic snake, 138
Argonauta, 74, 77.
Argonautidae, 81
Arius leiotetocephalus, 111, 118.
  thallasinus, 111.
  sp., 143, 144.
  spp., 12, 19, 135, 140, 149.
Arthropoda, 81
Asohos, 109, 110.
Astronesthes, 76, 79.
  Astronesthidae, 78, 79.
  Atherina californiensis, 19.
  hepsetus, 30
Atyidae, 226
Auxis, 76, 77, 80, 81.
  thazard, 112.
Avicennia officinalis, 184
Ayungin, 135, 141, 145, 147, 149, 152.

B

Bagoong, 2, 9, 50, 84, 109.
Baird, 61, 67, 73, 162, 166.
Bakawan, 149, 150.
Bakokong moro, 109, 110.
Balila, 110.
Balilin, 225
Baling, 6, 9, 10, 50.
Balingan, 10.
Balistes, 72.
Belonidae, 76, 80.
Bambangin, 109, 110.
Bamboo, 125.
Bambusa spinosa, 125, 184, 189.
Banak, 110, 113, 114, 118.
Bangos, 110, 114, 116, 118.
Bantala-an, 226.
Barcelona, 141,
Barium, 107.
Barnacle, 75, 81.
Barnea, 184.
Barnes, 66, 69.
  manilensis Phil., 185.
Barracuda, 225.
Batangan, 125.
Batog, 225.
Bayang, 225.
Beach seine, 9, 10, 50.
Beam trawl gear, commercial, 123
Belonidae, 76, 80.
Berycomorphi, 80.
Bia, 109, 110.
  puti, 113, 116, 118.
Bidbid, 110, 114.
Big-eyed scad,
  tuna, 72.
Bisig, 12.
Bisugo, 110, 113, 114.
Biya, 123, 138, 139, 140, 141, 142, 145, 146, 147, 148.
  puti, 118, 121, 135.
Blenniidae, 80.
Blue fish, 118.
Boat, 161.
Bocawan nga buca, 225.
Bolinas, 225.
Borers, 184.
Bramidae, 78, 80.
Bramids, 77.
Bright, 169.
Bromine, 107.

Buan-buan, 109, 110, 113, 114.
Buguing, 110.
Bulan-bulan, 6, 7, 109.
Bulao, 225
Bumpus, 66, 69.
Bungalin, 185.
Bongalon, 185.
Butete, 110.
Butterfish, 107.
Butterfly, 76, 110.

C

Caesio, 76, 80.
caerulaureus, 110.
cuning, 110, 116, 118.
lunaris, 110.
Calamus spp., 208.
Calcium, 107, 118.
CALDITO, ELISA B., see SULIT, NAVARRO, SAN JUAN, and CALDITO.
Calothrix, 47, 52.
CAPCO, SANTIAGO R., see MANACOP and CAPCO.
Cape Johnson, 199.
Carangidae, 79, 80.
Caranx, 76, 77.
kalla, 112.
malabaricus, 115, 118.
sexfasciatus Q. & G., 80, 112.
spp., 225.
Centriscidae, 76.
Carrothers, 169.
Caryphaena hippurus Linn., 73.
Cast net, 11, 50.
Catostomus commersonii Lessueur, 49.
Cavalla, 225
Centriscidae, 76, 80.
Cephalopoda, 74, 77.
Chaetodon sp., 110.
Chaetodontidae, 76, 80.
Chanos chanos, 110, 114, 116, 118, 225.
Chauliodontidae, 78
Chersydrus granulatus, 138, 149.
Chiasmodontidae, 79, 80.
Chiasmodontids, 76
Chirocentrus dorab, 112.
Chlorine, 107.
Chlorinity, 164
Chonophorus melanocephalus, 3.
ocellaris, 37, 41, 47, 50, 53.
Chordata, 81.
Cirripedia, 81.
Clams, 123, 135.
Clarias batrachus, 111, 135, 138.
Clupeidae, 79.
Coal-tar net preservative, development of a, 168.
Codfish, 107.
Collybus drachme Snyder, 78.
Conn, 168.
Contribution to the knowledge of the structure and composition of the water masses off eastern Philippines, a, 61.
Copper, 107.
Cornet fishes, 76.
Coryphaena hippurus Lac., 80.
Coryphaenidae, 80.
Cosmarium, 49, 52.
Cottons twines, 171, 173, 174, 175.
Crab larvae, 77.
Crabs, 77, 75, 81.
Croaker fillet, 107.
Crustacea, 75, 77.
Cutlass fish, 75.
Cybium commerson, 112, 117, 118.
Cynoglossus puncticeps, 111.
sp., 118.
Cyrena manillensis, 135.

D

Dactyloptena, 77
Dactylopteridae, 76, 80.
Dalag, 109, 110, 135, 138, 141, 149.
Dalagang bukid, 109, 110, 113, 116, 118.
Damis, 110.
lawin, 110, 113, 118.
Damsel fishes, 76.
Danish deep-sea expedition of the "Galathea" to the Mindanao Deep, 197.
Dapang bilog, 109, 110.
sinilas, 111, 110.
DATINGALING, BIENVENIDO, see SULIT, DATINGALING, and PANGANIBAN.
Decapoda, 80, 81.
Decapterus, 76, 80.
macroma, 111.
Decca radar, 197.
Defant, 66.
Deprane, 225
punctata, 111, 225.
Development of a coal-tar net preservative, 168.
Devil fish, 225
Diablo Pass, 122.
Digested fishes, 80.

Dilis, 109, 111, 113, 116, 118.
Diodon, 76.
Diodontidae, 80.
Dissolved oxygen, 165.
Dolphin, 72, 73.
Dorado, 109, 111, 118.
frame, 129.
Dredge trawl, 121.
Dubos, 169.
Duck, 121
feed, 138.
industry, 127.
Dubay, 111, 118.
Duhol, 138, 149.
Dussumieria acuta, 112.
Dussumieridae, 76, 79.

E

Effect of salt, vinegar, and heat on the coliforms in oysters, the, 90.
Elagatis, bipinnulatus, 115.
Eleotris melanosoma, 3
Eleutheronema tetradactyla, 111.
Elops hawaiensis, 114.
Emden, 199.
Engraulis, 72.
Epinephelus corallicola, 115.
spp., 225.
Equipment and methods used in oceanographic investigations in the Philippines, 161.
Escherichia coli, 96, 99, 103.
Euthynnus spp., 226.
yaito Kishinouye, 73, 76, 78, 79, 80.
Exocoetidae, 76, 80.

F

Farrar, 169.
File fishes, 76, 77.
Fish barricades, 9, 11, 12, 50, 51.
meal, 107.
paste, 2, 9, 84, 109.
salted, 84.
sauce, 9, 84.
catadromus, 22.
Philippine, 106
Fishing craft, motorized, 126.
motor launch-towed, 127.
gear, types of, 9,
Fistulariidae, 76, 80.
Flat heads, 76, 77.
Fleming, 169.
Flourine, 107.
Flying fishes, 76, 77.
gurnard, 76, 77
Food habits of tunas and dolphins based on examination of their stomach contents, 72.
Freshwater catfish, 135, 138.
theraponid, 135

G

Gagaong, 116, 118.
Galathea, 197, 201, 203.
Galeidae, 225
Galongong, 111
Gar fishes, 76
Gastrochaena, 184.
rostrata Speng., 184, 186.
Gele, 111, 115.
Gemmylidae, 79, 80.
Gempylus, 76, 77.
serpens, 78.
serpens C. & V., 79, 80.
Gerres filamentosus, 111.
Gill, 73.
nets, 123.
Gislen, Torsten, 198.
Glossogobius, 152.
giurus, 3, 22, 118, 121, 135, 140, 142, 149, 151, 152.
celebius, 3.
Goat fishes, 76.
Gobiidae, 1, 22.
Gobiodea, 3.
Goby dredge-trawl fishery of Laguna de Bay, with notes on the composition of the commercial catches, the, 121.
fry, 42, 43.
fry fishery of Cagayan River, Oriental Mindoro, 1.
Golgol, 9.
sa anga, 11, 51.
sa hipon, 50.
Grouper, 225.
Guinamus, 9.
Guitar fish, 225.
Gulaphallus falcifer, 30.
mirabilis, 12, 16, 30.

H

Habas, 225.
Haddock, 118.
Hagnaya, 208.
Hair tail, 225.
Half beaks, 76.
Halibut, 118.
Hapin, 129.

Hasa-Hasa, 109, 111.
Hasang, 205.
  moderno, 205, 206, 210.
Hatchet fish, 76.
Heko, 9.
Helland-Hansen, 62.
Hemiramphus far, 110.
Hemirlamphids, 77.
Hemiramphidae, 76, 80.
Herring, 76, 109, 118.
  dried, 84.
  like fishes, 77.
Hipon, 1, 51, 53, 135.
  fry, 37, 39, 42, 43, 49.
Hito, 111, 135.
Holocentridae, 80, 77.
Holocentrus, 76, 77.
Horn fishes, 76, 77.
Hydrogen ion, 166.
Hynnis momsa, 110.
Hypostomides, 80.

I

Ilak, 111, 118.
Iniomi, 76, 77.
Inorganic phosphates, 165.
Invertebrates, 80.
Iodine, 107.
Ipon, 1.
  fisheries, 45.
Iron, 107.
Iso, 113, 115.
Isospondyli, 77.

J

Japanese utase, 123.
Johnson, 169.

K

Kabasi, 111.
Kaing, 145.
Kaladkad, 123, 129.
  pambiya, 123, 149.
Kalaso, 111, 118.
Kalumpini, 185.
Kandule, 111, 135, 136, 137, 138, 139, 140, 141, 143, 144, 149.
  bongoan, 111, 118.
Karingkaring, 147.
Katawan, 131.
Katsuwonus pelamis (Linn.), 73, 77, 79, 81.
Kilassi, 185.
Kitang, 111, 123.
Kohol, 135.
Krummel, 66.
Kuyapi, 185.
Kyphosys lembus, 111, 118.

L

Labahita, 109, 111, 118.
Labridae, 76, 80.
Lactariidae, 80.
Lambat, 129.
Lantern fishes, 76, 77.
Lapad, 84.
Lapu-Lapu, 109, 111, 115, 116, 118.
Lates calcarifer, 110, 114.
Lattice method of oyster culture, 189.
Lead, 107.
Leather jackets, 255.
Leiognathus, 72.
  equulus, 112, 117, 118.
Leptocephalus larva, 80.
Lestidium philippina (Fowler), 76, 78, 79.
Leuresthes tenius, 12, 19.
Life history and habits of the goby, Sicyopterus extraneus Herre (anga) Gobiidae with an account of the gobyfry fishery of Cagayan River, Oriental Misamis, the, 1.
Lizard fishes, 76, 77.
Liver, 107.
Liwit, 225.
Lobster, 72, 75.
Loligo spp., 226.
Lumba-lumba, 226.
Lutianidae, 80.
Lutjanus fulvus, 110.
  malabaricus, 111, 118.
  sp., 115.
Lyman, 66, 69.
Lyngbya, 48, 52.

M

Mackerell, 107.
Magnesium, 107.
Malabon solar salt, 93.
Malakapas, 111.
Malaking mata, 111, 118.
Malasugi, 226.
Mamale, 111.
Maming, 225.
MANACOP, PORFIRIO R., The life history and habits of the goby, Sicyop-

terus extraneus Herre (anga) Gobiidae with an account of the goby-fry fishery of Cagayan River. Oriental Misamis, 1.
MANACOP, PORFIRIO R., and SANTIAGO R. CAPCO. The goby dredge-trawl fishery of Laguna de Bay, with notes on the composition of the commercial catches, 121.
Mangitit, 185.
Manungdaan, 10
Mariano, 225.
Maya-Maya, 109, 111, 118.
Mayang, 111.
Mayapis, 125.
McBeth, 169.
MEDINA, RICARDO R., see MEGIA, RONQUILLO, and MEDINA.
Megalaspis cordyla Linn., 80, 112, 115.
Megalopa, 77.
larva of crab, 81.
Megalops cyprinoides, 110, 114.
MEGIA, TEODORO G., see VILLADOLID, MEGIA and RONQUILLO.
MEGIA, TEODORO G., and ALFONSO R. SEBASTIAN. Equipment and methods used in oceanographic investigations in the Philippines, 161.
MEGIA, T. G., and D.V. VILLADOLID. A contribution to the knowledge of the structure and composition of the water masses off eastern Philippines, 61.
MEGIA, TEODORO G., INOCENCIO A. RONQUILLO and RICARDO R. MEDINA. Notes and observations on the Danish deep-sea expedition of the "Galathea" to the Mindanao Deep, 197.
Melanid snails, 122.
Mene maculata (Bc. & Schn.), 80. 225.
Menhaden Reductive Industry, 107.
Menidae, 80.
Menidia menidia, 30.
Mesopristes plumbea, 16
Miapi, 185.
Mindanao Deep, 197.
Mirogobius lacustris, 22.
Mistichtys luzonensis, 22.
Mobula spp., 225.
Mola mola, 72.
Mollusca, 80.
Mollusks, 72, 74.
fresh-water, 121.
Two Philippine boring, 184.
Momsa, 225.
Monacanthidae, 76, 80.
Monotaxis grandoculis, 111.
grandoculus, 118.
Moon fish, 225.
Mudfish, 131.
Mugil dussumieri, 112.
vaigiensis, 110, 114, 118.
spp., 135, 138.
Muli, 50, 51.
fry, 37, 47, 52.
Mullet, 135, 138.
Mullidae, 76, 80.
Muraenesox cinereus, 112.
Murrel, 135, 138.
Musa textilis, 10.
Myctophidae, 76, 79.
Myripristis, 76.

N

NAVARRO, OLYMPIA B., see SULIT, NAVARRO, SAN JUAN, and CALDITO.
Nemipterus taenipterus, 110, 114.
Neothunnus macropterus (Temm and Schl.), 72, 73, 78, 79.
New hasang moderno, a fish corral used in the Philippine waters, the, 205.
No-os, 226.
North Pacific Equatorial Current, 66, 70.
Notes and observations on the Danish deep-sea expedition of the "Galathea" to the Mindanao Deep, 197.

O

Oceanic bonito, 73.
Oceanographic investigations in the Philippines, equipment and methods used in, 161.
Octopoda, 81.
Octopus, 77.
Oedogonium, 49, 52.
Octopuses, 74.
Omosudidae, 79.
Omosudis lowei Gunthes, 76, 79.
Onchorynchus, 23.
Ophicephalus striatus, 110, 135, 138, 149.
Ophiocara aporos, 3.
Oriles, 112, 113, 115.
Ostracion, 72, 76.
Ostraciontidae, 80.
Ostrea cucullata Born, 191.
edulis, 191.
iredalei, Faustino, 191.
malabonensis Faustino, 191.
palmipes Sowerby, 191

Outlook of the Philippine tuna fisheries, an, 158.
Onxer-Knudsen method, 164.
Oysters, 93, 103.
culture, lattice method of, 189.

P

Pacific Equatorial Counter Current, 61, 66.
equatorial water, 63, 64.
salmon, 23.
Pakpak, 131.
Palaemon lanceifrons, 135.
Palañgoy, 125.
Palinuridae, 81.
Palos, 112.
Palosapis, 125.
Paltek, 126.
Palumbo net, 201.
Pampano, 225.
Panalok, 138.
PANGANIBAN, PACIFICO, see SULIT, DATINGALING, and PANGANIBAN.
Pante, 123.
Panuig, 6, 7, 50.
Papan, 135, 138.
Paper nautilusces, 74.
Parang-parang, 112.
Parapholas concamerita Desh., 184.
Paripa, 129.
Parisukat, 129.
Parrot-fish, 76.
Pating, 112, 225.
Patis, 9, 84, 87.
Pegasidae, 76, 80.
Penium, 49, 52.
Pepisik, 185.
Percomorphi, 77, 80.
Philippine boring mulluscs, two, 184.
market fishes, proximate chemical composition of various species of, 106.
tuna fisheries, an outlook of the, 158.
water masses, 61.
Phyllosoma larva of spiny lobster, 77, 81.
Pholas orientales Gmelin, 184.
Phosphorus, 107, 113, 118.
Piapi, 185.
Pindanga, 112.
Pipe fishes, 76, 77.
Planet, 199.
Platycephalidae, 76, 80.
indicus, 112.
Plectognathi, 77, 80.
Plectropomus sp., 111, 116, 118.
Polynemidae, 80.
Pomacentridae, 80.
Pomadasys hasta, 110, 114.
Pomacentridae, 76.
Porpoises, 226.
Potassium, 107, 113.
Prawns, 135.
Priacantidae, 80.
Proximate chemical composition of various species of Philippine market fishes, 106.
Pseudaluteres nasicornis (Schlegel), 80.
oligodon, 110.
Preropoda, 80.
Pundung, 185.
Pusil-pusil, 11, 15.
Pusod, 131.

R

Rachycentron canadus, 111, 115.
RASALAN SANTOS B., The new hasang moderno, a fish corral used in the Philippine waters, 205.
Rastrelliger brachysomus, 111, 225.
chrysozonus, 110, 116, 118, 225.
Rattan, 208.
Remorke, 129.
Rexia solandri (Cuvier) 79, 80.
Rhizophora candelaria DC., 149, 150.
Rhynchobatus djiddensis, 225.
Robertson, 169.
RODRIGUEZ, P., see UYENCO, RODRIGUEZ, and TARUS.
RONQUILLO, INOCENCIO A., Food habits of tunas and dolphins based upon the examination of their stomach contents, 72, see also MEGIA, RONQUILLO, and MEDINA; VILLADOLID, MEGIA, and RONQUILLO.

S

Sailboat fishing craft, 125.
SALAFRANCA, ENRIQUE S., The effect of salt, vinegar, and heat on the coliforms in oysters, 90.
Salay-salay aso, 112.
Salindato, 225.
Salmon, 107, 113, 115.
Salmonella, 101, 103.
Salt, 90.
concentration of commercially dried (tuyo) and smoked (tinapa) herring, studies on the, 84.
Salted fish paste, 50.

Samaral, 112, 118.
SAN JUAN C., see SULIT, NAVARRO, SAN JUAN, and CALDITO.
Sap-sap, 112, 117, 118.
Sarap, 50.
Sardinella, 76, 79.
fimbriata, 84, 112.
longiceps, 84, 112.
perforata, 84.
Sardines, 76.
Saurida tumbil, 111, 118.
Scaridae, 76, 80.
Scatophagys argus, 111.
Scissors nets, 9, 50.
Scleroparei, 77, 80.
Scoliodon palasorrah, 112.
Scomberoides lysan, 111, 112, 118.
spp., 225.
Scomberomorous commersoni, 226.
Scombridae, 80.
Scoop nets, 138.
seine, 214.
Scripps Institution of Oceanography, 62.
Sea catfishes, 135.
fleas, 77.
mantis, 77.
moths, 76.
SEBASTIAN, ALFONSO R., see MEGIA and SEBASTIAN.
Selar crumenophthalmus, 225.
Seriola nigrofasciatia (Ruppell), 78, 79, 80.
Serranus atrarius, 33.
Set lines, 123.
Shark, 225.
Shorea palosapis (Blanco) Merr., 125.
Shrimp fishes, 76.
Shrimps, 77, 81, 226.
Sicyopterus, 3, 4, 50.
extraneus Herre, 1, 3, 4, 5, 12, 23, 33, 36, 37, 41, 47, 50, 51, 53.
fuliag, 3.
garra, 4, 49.
gymnaucheun, 4, 22.
lacrymosus, 3.
Siganidae, 80.
Siganus, 76.
Sigin, 214, 215, 216.
Silicates, 165.
Silicon, 107.
Sillago sihama, 110.
Simpsonella subcrassa, 135, 138.
Skipjack, 73, 225.
Snake, 138.
Snellius, 162, 199.
Sodium, 107.
Soldier fishes, 76.
Solenichthyes, 80.
Spanish mackerel, 112, 117, 118, 226.
Sparus berda, 110.
Spear gun, 11, 51.
Spencer F. Baird, 61, 73, 81.
Sphyraena, 72.
jello, 112, 117, 118.
spp., 225.
Spiny-rayed fishes, 77.
Spirogyra, 48, 52.
Spleen, 107.
Squids, 72, 74, 77, 226.
Squirrel fishes, 77.
Stegiocloniùm, 48.
Sternoptychiidae, 79.
Sternoptyx diaphana Hermann, 76, 79.
Stigeoclonium, 52.
Stolephorus, 72.
commersonii, 111, 116, 118.
indicus, 111, 116.
Stomatidae, 78.
Stomatopoda, 77, 81.
Stomiatidae, 78.
Stromateus niger, 111, 118.
Strontium, 107.
Studies on the salt concentration of commercial dried (tuyo) and smoked (tinapa) herring, 84.
Sudidae, 78, 79.
Sudis rissoi Bonaparte, 76, 78, 79.
Sulfur, 107.
Sulib, 138.
Sulid, 135.
SULIT, JOSE I., OLYMPIA B. NAVARRO, REGINA C. SAN JUAN, and ELISA B. CALDITO, Proximate chemical composition of various species of Philippine fishes, 106.
SULIT, JOSE I., BIENVENIDO DATINGALING, and PACIFICO PANGANIBAN, Development of a coal-tar net preservative, 168.
Sunfish, 72.
Sunga, 225.
Sunog, 112.
Supot, 131.
Surgeon fish, 75.
Sverdrup, 63.
Swordfish, 226.
Sygnema, 49, 52.
Synbranchus bengalensis, 112.
Synentognathi, 80.

Syngnathidae, 76, 80.
Synodontidae, 76, 79.

T

Taclob, 11, 51.
Talakitok, 112, 113, 115, 117, 118.
Talilong, 112, 135.
Talipa, 112.
Tamban, 84, 112.
Tangigue, 226.
Tautoga onitis, 33.
TARUC, R., see UYENCO, RODRIGUEZ, and TARUC.
Taylor, 168.
Tetanium, 107.
Tetragonuridae, 78, 80.
Tetraodon, 76.
sp., 110.
Tetraodontidae, 80.
Tetrognurus cuvieri Risso, 78.
Teuthididae, 75, 78, 80.
Teuthis javis, 112, 118.
Texaspahic Net Drip., 170.
Thaliacea, 81.
Theodore N. Gill, 73.
Therapon plumbeus, 135, 141, 149.
theraps, 116, 118.
Thermometers, 162.
Tinapa, 84, 88.
Torcillo, 112, 117, 118.
Towline, 129.
Triacanthidae, 76, 80.
Trichiuridae, 80.
Trichiurus, 75, 77.
haumela, 110, 225
Trigger-fishes, 76, 77.
Tugnos, 45, 52.
Tulingan, 112, 109, 225, 226.
Tulis, 112.
Tulya, 135.
Tuna, 72, 118.
fisheries, Philippine, an outlook of the, 158.
Tunicata, 81.
Tunsoy, 84, 112.
Tuyo, 84, 85, 88.

U

Uranoscopidae, 80.
UYENCO, V., P. RODRIGUEZ, and R. TARUC, Studies on the salt concentration of commercially dried (tuyo) and smoked (tinapa) herring, 84.

V

Vanadium, 107.
VILLADOLID, D.V., see MEGIA and VILLADOLID.
VILLADOLID, D.V., TEODORO G. MEGIA, and INOCENCIO A. RONQUILLO. An outlook of the Philippine Tuna Philippines, 158.
Vinegar, 91, 99.
Vivipara angularis, 138.
Viviparid snail, 135.

W

Water bottles, 163.
masses off eastern Philippines, a contribution to the knowledge of the structure and composition of the, 61.
Western California, 62.
North Pacific Central water, 61, 63, 64, 65.
White fish, 118.
goby, 121, 135.
sucker, 49.
leather and Brown, 169.
Wooden float, 125.
Wrass, 76.

X

Xiphasia setifer Swainson, 78, 79, 80.
Xiphasiidae, 79, 80.
Xiphias gladius, 226.

Y

Yaito tuna, 226.
Yellow tuna, 226.
Yellowfins, 72.
tuna, 72, 73.

Z

Zanclidae, 79, 80.
Zanclus canescens Linn., 78, 79, 80.
Zeomorphi, 80.
Zinc, 107.
Zo-Bell, Claude E., 201, 202, 198.
Zoea, 77.
larva of crab, 75.

EDITORIAL BOARD

EDITOR-IN-CHIEF

D. V. VILLADOLID, PH.D.
Director of Fisheries

MANAGING EDITOR

EDUARDO R. ALVARADO, A.B., LL.B.
Project Director
Office of Agricultural Information
Department of Agriculture and Natural Resources

ASSOCIATE EDITOR

AMANDO D. SINGSON, A.B.
Chief, Division of Publications
Office of Agricultural Information

CONTRIBUTING EDITORS

HERACLIO R. MONTALBAN, M.A.
Chief, Division of Fish Culture and Fisheries Biology

HERBERT E. WARFEL, M.Sc.
Biologist

CLARO MARTIN, B.Sc.
Chief, Division of Fisheries Technology

ANDRES MANE, B.S.A.
Superintendent, Philippine Institute of Fisheries Technology

Pelagic-Neretic Fisheries:
DANIEL BUNAG, B.S.A.

Estuarine Fisheries:
GUILLERMO J. BLANCO, M.Sc.

In-land Fisheries:
PEDRO ACOSTA, B.S.F.

Hydrology:
ALFONSO R. SEBASTIAN, B.Sc.

Gear Technology:
PORFIRIO R. MANACOP, M.A.

Food Technology:
JOSE I. SULIT, M.Sc.

Socio Economics:
JOSE R. MONTILLA, B.Sc.

Fisheries Legislation:
JOSE G. SANCHEZ, LL.B.

BUREAU OF FISHERIES AND AQUATIC RESOURCES
Quezon City, Metro-Manila
Philippines